Development Guide and Strategic Management of Fossil Energy Resources in Kosovo for the Long Term Energy Supply of the Country

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Abstract (English)

Development and Strategic Management of Fossil Energy Resources in Kosovo for the Long Term Energy Supply

The purpose of this research is multidimensional evaluation of fossil energy resources in Kosovo, as well determination of the possible development scenarios in lignite mining and energy production in long term view in order to facilitate strategic management of lignite resources and decision making for the stable energy supply of the country. The economic development in all transition countries, including Kosovo, has proven how difficult it is to manage owned natural resources properly and benefit from them. These difficulties are firstly related with big variation of the main energy and economic indicators, lack of an appropriate and effective infrastructure to collect data and select an appropriate methodology for sector development, especially during the transition period. Difficulties become greater in the existing situation where for different sectors of the Kosovo's economy there are still does not exist development strategies. The final aim of this work is to develop a guide for the strategic assessment of fossil fuel resources regarding the appearing and space-consuming aspects relevant for environment and with it a basis for the production of a raw material protection strategy.

Minerals and energy sector was the staple of the economy and generated a significant amount of income and many jobs in Kosovo in the past. Actually the mining sector presents opportunities for economical development. Improvements in the energy sector are necessary to support the growing business sector that is directly linked with other sectors such as transportation, construction, services that will help overall economical growth in the country.

Demand for energy in the region will increase considerably in the coming years and Kosovo, with its quality and easy-to-extract lignite, is well placed to also supply the emerging regional market. Nevertheless, for all the comparative advantage that Kosovo has in this sector, no country, including oil-rich countries relies exclusively on energy production. The relation between the country's economic development and the energy demand is considered as a key issue and is represented as a closed cycle. This cycle includes many economic, social and technological analyses. In order to clearly define the correlations between them, many studies are needed in the economic, spatial, environmental and social development sectors. The main objectives of the lignite exploitation strategy for the economic development of the energy sector in Kosovo are the following:

- Encouragement of exploration and use of domestic deposits of lignite in an environmentally responsible way.
- Development of long term plans for lignite mining in various locations based in regionally divided lignite basins in Kosovo, ensuring proper spatial planning permissions and protection of lignite deposits areas.

- Preparation of a clear and stable fiscal framework that will be attractive for private investors to develop lignite fired generating facilities in the future.
- Reclamation strategy of current and previous lignite mining areas.
- Increase public awareness about economic benefits from lignite exploitation for energy production and stable supply with electricity.

The extraction of energy mineral resources nowadays is becoming very important. Mineral resources management today has become part of sustainable development. The long-term intergeneration contract for sustainable development challenges in the mineral industry aims to increase its eco-efficiency by increasing resource utilization ratios and reducing environmental impacts.

The structure of the work starts with an introduction, followed by the problem description, the investigation methodology as well as a presentation of the bases of the raw material protection. Because the strategic guide should be developed for the lignite raw material protection and efficient use of it, a chapter about the lignite importance for Kosovo was predone for a medium and long-term reliable energy supply. This part is complemented with figures, tables and graphs. For the existing Kosovo open pit mines and future possible lignite fields an assessment is carried out, which should make easier later strategic decisions concerning the secure energy supply Kosovo. Into this assessment the space-consuming aspects are included which are also relevant for environment. For this study it was rather important developing a strategic guide and establishing a long term strategy for lignite utilization and secure energy supply for the country based as well in regional dispersion of lignite resources.

Kosovo is a country of immense mineral wealth. Reserves of lignite, in particular, are considered sufficient to provide the country with energy for several hundred years. But the exploitation of Kosovo's lignite reserves must proceed rationally. Because lignite is fossil source of energy, the use of it can lead to major structural changes in the landscape, damaging living conditions and triggering socio-economic constrains. As small country of only 10,904 km^2, Kosovo must develop a clear strategic vision for its economic, spatial, and social future. This is the only way to guarantee the country's sustainable economic development.

Despite its effect on spatial and economic development, the management of domestic natural resources and use of lignite resources in Kosovo has not yet been adequately studied. There has been no multi-sector analysis; therefore, this research work is concentrated in analysis and possible potentials for utilization of lignite as strategic fuel for energy production in order to drive the economic developments in the country. At the end a number of recommendations are given to help decision-makers find an economically viable solution, which is fairer and ensures cleaner environment for the citizens of Kosovo. Kosovo urgently needs energy to guarantee its unimpeded economic development in the coming years. In the context of lignite-exploitation, the power generation cycle involves several stages: mining of lignite; separation and processing of lignite; transport to the power plants; combustion; transport, and storage of fly ash and overburdens. Conducted on a large scale, this can trigger numerous constrains, most conspicuously between:

1) National and regional development planning in mining and energy sectors

2) Mining and agricultural land use, mining and natural protected areas

3) Mining and existing settlements, industrial facilities, infrastructure, and water supplies

4) Power production and the environment

5) Lignite development vs. energy demand, extraterritorial jurisdiction, water supply availability

On the basis of all this information, including data analysis the research helps to develop and recommend lignite exploitation in long term and in each case the utilization has to ensure that the country and citizens are the main beneficiaries. The most important requirement in this context is a sustainable, effective and economic use of those deposits. The energy demand will double within next decade, therefore to meet this demand it is necessary to take early measures to compete the protection of existing deposits and start immediately actions for the new mining activities. With an increasing use of space in the form of settlements, fresh water shortage, air quality, natural protected areas or heritage facilities, infrastructure facilities, the protection of mineral resources becomes increasingly difficult. Therefore, a medium-and long-term secure protection of fossil fuel deposits can be achieved only by an appropriate resource management strategy.

Based on the regional spreader deposits in Kosovo, a concept of the evaluation of mineral raw materials will be developed and will occur, which takes into consideration most important factors, such as raw material quality and quantity, constrain potentials, infrastructure, regional dispersion and possible protected areas. Based on the evaluation results, a ranking of special protection, less expensive parts of the deposit is developed, which in turn serves as the basis for recommendations for future utilization of lignite raw materials through Kosovo. Finally, this specially developed assessment for the lignite energy resources of Kosovo can be applicable with minor modifications of the weighting factors on all commodities and regions.

Zusammenfassung

Entwicklung und strategisches Management der fossilen Energieressourcen im Kosovo für die langfristige Energieversorgung

Der Zweck dieser Untersuchung ist, die fossilen Energieressourcen im Kosovo zu studieren und zu bewerten, sowie die möglichen Entwicklungsszenarien im Braunkohlenbergbau und in der Stromerzeugung in der langen Frist aufzuzeigen. Die wirtschaftliche Entwicklung in allen Transitionsländern einschließlich des Kosovo hat gezeigt wie schwierig es ist, die Ressourcen richtig zu verwalten und davon profitieren zu können. Diese Schwierigkeiten sind zunächst verbunden mit einer großen Variation der wichtigsten Energie- und Wirtschaftsindikatoren, dem Mangel an einer angemessenen und effektiven Infrastruktur für Daten und der Auswahl einer geeigneten Methode zur Analyse der Trends für die Energieressourcen und dem Energieverbrauch. Die Schwierigkeiten werden größer in der bestehenden Situation, weil es für verschiedene Sektoren der Wirtschaft im Kosovo keine klare Entwicklungsstrategie gibt. Die hier vorgestellte Arbeit hat den Zweck, einen Leitfaden für die strategische Bewertung der fossilen Ressourcen und die entscheidenden raumgreifenden, relevanten Aspekte für die Umwelt zu entwickeln und damit eine Grundlage für die Erstellung einer Rohstoffstrategie zu schaffen.

Der Rohstoff- und Energiesektor war in der Vergangenheit das Rückgrat der Wirtschaft und sicherte eine erhebliche Menge an Einkommen und Arbeitsplätzen im Kosovo. Der Bergbau birgt Chancen für die wirtschaftliche Entwicklung. Verbesserungen im Energiesektor sind erforderlich, um die wachsende Ökonomie zu unterstützen. Um zum gesamtwirtschaftlichen Wachstum des Landes beitzuragen, ist eine stärkere Verknüpfung mit anderen Sektoren, wie Transport, Bau und Dienstleistungen erforderlich. Die Nachfrage nach Energie in der Region und im Kosovo wird in den kommenden Jahren deutlich steigen. Die qualitativ hochwertige und leicht abbaubare Braunkohle im Kosovo ist gut geeignet, den entstehenden regionalen Markt mit Energie zu beliefern. Trotzt aller genannten Vorteile der Braunkohlegewinnung im Kosovo stützt sich kein Land, einschließlich der ölreichen Ländern, ausschließlich auf die Energieerzeugung, um die ökonomische Entwicklung zu steigern. Das Verhältnis zwischen der wirtschaftlichen Entwicklung des Landes und dem Energiebedarf ist eng miteinander verknüpft und kann als geschlossener Zyklus dargestellt werden. Dieser Zyklus umfasst viele wirtschaftliche, soziale und technologische Analysen. Um die Zusammenhänge klar zu definieren, sind viele Studien der wirtschaftlichen, räumlichen, ökologischen und sozialen Sektoren erforderlich. Die Hauptziele der Strategie zum Abbau der Braunkohle für die wirtschaftliche Entwicklung des Energiesektors im Kosovo sind die folgenden:

- Förderung der Erforschung und Nutzung des heimischen Vorkommen der Braunkohle in ökologisch vertretbarer Weise.

- Entwicklung von langfristigen Plänen für den Braunkohlenbergbau an verschiedenen Orten im Kosovo, einschließlich der Sicherung der ordnungsgemäßen Raumplanungsberechtigungen und dem Schutz der Gebiete, in denen sich Braunkohlevorkommen befinden.
- Erstellung klarer und stabiler steuerlicher Rahmenbedingungen, die attraktiv sind für private Investoren.
- Die Rekultivierung früherer Braunkohletagebaue.
- Sensibilisierung der Öffentlichkeit für die wirtschaftlichen Vorteile der Braunkohlegewinnung für die Stromerzeugung.

Der Abbau von mineralischer Ressourcen ist für die globale Energieversorgung von großer Bedeutung. Das Management mineralischer Ressourcen muss Bestandteil der nachhaltigen Entwicklung sein. Der langfristige Vertrag zwischen den Generationen für eine nachhaltige Entwicklung stellt Herausforderungen für die Rohstoffindustrie und ihre ökologische Effizienz durch Erhöhung der Ressourcennutzung dar. Die Struktur der Arbeit beginnt mit einer Einführung in die Problembeschreibung der Untersuchungsmethodik sowie einer Darstellung der Grundlagen zur Rohstoffsicherung. Da das Ziel die Rohstoffsicherung und die effiziente Nutzung der Braunkohle entwickelt werden soll, wird die Bedeutung dieses wichtigen Energierohstoffes für den Kosovo für eine langfristige und zuverlässige Energieversorgung analysiert. Dieser Abschnitt wird mit Zahlen, Tabellen und Grafiken ergänzt. Für die bestehenden und zukünftigen Braunkohletagebaue im Kosovo erfolgt eine Bewertung, in denen andere Maßnahmen durchgeführt werden, die eine zukünftige Entscheidung über die Energieversorgungssicherheit des Kosovo liefern soll. In diese Bewertung werden die raumgreifenden Aspekte einbezogen, die auch relevant für die Umwelt sind. Für diese Studie war es eher wichtig eine Idee der langfristigen Strategie für die Braunkohlenutzung und die sichere Energieversorgung für das Land zu entwickeln.

Das Kosovo ist reich an Bodenschätzen. Die Vorräte insbesondere an Braunkohle werden als ausreichend betrachtet, um das Land für mehrere hundert Jahre mit Energie zu versorgen. Aber die Nutzung der Braunkohlevorräte mussen rational vorgehen. Darüber hinaus kann der Einsatz von Braunkohle zu wesentlichen strukturellen Veränderungen in der Landschaft, zu veränderten Lebensbedingungen und Auslösung sozio-ökonomischer Konflikte führen. Als ein kleinflächiges Land mit nur 10.904 km^2 muss der Kosovo eine klare strategische Vision für die wirtschaftliche, räumliche und soziale Zukunft entwickeln. Dies ist der einzige Weg, um eine nachhaltige wirtschaftliche Entwicklung im Kosovo zu garantieren. Die Verwendung von Braunkohle kann eine Vielzahl von Entwicklungskonflikten lösen. Die ordnungsgemäße strategischen Planung ist das einzige Mittel, die widerstreitenden Interessen zwischen den Akteuren wirksam zu vereinen.

Die Wirkung auf die räumliche und wirtschaftliche Entwicklung im Kosovo ist noch nicht ausreichend untersucht. Es existiert keine Multi-Sektor-Analyse, weshalb sich diese Forschungsarbeit auf die Analyse der möglichen Potenziale für die Nutzung der Braunkohle als strategischer Energierohstoff konzentriert. Am Ende der Analyse wird eine Reihe von Empfehlungen gegeben, die dem Entscheidungsträger eine wirtschaftliche Lösung erleichtert. Der Kosovo braucht dringend eine zuverlässige Stromerzeugung, um die wirtschaftliche Entwicklung in den kommenden Jahren zu gewährleisten. Im Zusammenhang mit der

Braunkohlenutzung beinhaltet der Stromerzeugungszyklus mehrere Stufen: Abbau der Braunkohle, Trennung und Verarbeitung der Braunkohle, Transport zu den Kraftwerken, Verbrennung, Trennung, Transport und Speicherung der Asche. Dirigiert im großen Maßstab, kann dies Auslöser zahlreicher Konflikte sein. Insbesondere bestehen die Konflikte zwischen:

1) Nationale und Regionale entwiklungen in Bergbau und Energie bereichen
2) Bergbau und Landwirtschaft
3) Bergbau und bestehenden Siedlungen, Industrieanlagen, Infrastruktur und Wasserversorgung
4) Der Stromerzeugung und der Umwelt.
5) Braunkohle Entwicklung vs Energiebedarf, Exterritoriale Juridicstion,Wasserversorgung Verfügbarkeit

Auf der Grundlage all dieser Informationen, einschließlich der Datenanalyse der Forschung können Empfehlungen zur langfristigen Entwicklung und Abbau der Braunkohle ausgesprchen werden. In jedem Fall sollte die Rohstoffsicherung mit den Nutzungskonflikten abgewogen werden. Die wichtigste Voraussetzung in diesem Zusammenhang ist eine nachhaltige, effiziente und wirtschaftliche Nutzung der bekannten Lagerstätten. Um der Nachfrage gerecht zu werden, ist es notwendig, frühzeitig Maßnahmen zu ergreifen, die vorhandenen Lagerstätten zu sichern. Mit zunehmender Nutzung des Raums in Form von Siedlungen, Schutzgebieten, Infrastruktur u.a. nimmt die zur Rohstoffgewinnung zur Verfügung stehende Fläche ab. Die mittel-und langfristige Sicherung von Lagerstätten kann nur durch eine geeignete proaktive Strategie erreicht werden. Basierend auf den Lagerstätten im Kosovo wird ein Konzept der Evaluierung mineralischer Rohstoffe entwickelt. Das Konzept berücksichtigt wichtige Faktoren wie die Rohstoffqualität und -quantität, Konfliktpotentiale, die Infrastruktur und mögliche Schutzgebiete. Basierend auf der Bewertung wird ein Ranking der bedeutendsten Braukohlegebiete erstellt. Das Ranking soll sicher stellen, dass zukünftig Lagerstätten ohne große Konfliktpotenziale erschlossen werden können, was wiederum als Grundlage dient für die strategischen Empfehlungen und Entscheidungen. Die speziell entwickelte Bewertung für die Braunkohlevorräte des Kosovo kann mit geringfügigen Modifikationen der Gewichtungsfaktoren auch auf andere Rohstoffe und Regionen angewendet werden.

Chapter I

1. INTRODUCTION AND IDENTIFICATION OF THE PROBLEM

Mineral resources are very important for development of each country and especially for Kosovo where lignite is of outstanding importance to energy and electricity generation in the land. It contributes almost to 97% of the total electricity generation, the rest of 3% being hydro based power generation. Considering all the potential sources for power generation in Kosovo, lignite safely maintains its leading position. The Kosovo lignite mines are operating in one of the most favourable lignite deposits in the region due to its geological conditions. With an average stripping ratio of 1.7 m^3 of overburden to 1 ton of lignite, lignite production in Kosovo mines could supply competitively fuel to the power plant compared to international fuel sources and energy prices. The total estimated exploitable resources of approximately 12-14 Billion tones represent one of the richest lignite sources in Europe, which would enable ambitious power generation and expansion schemes in the coming decades. Lignite supply can rise in correlation with increasing electricity consumption.

Lignite can be supplied with the highest degree of security and with predictable price levels. By this, Kosovo can take advantage of its large reserves and of its location in centre of South East Europe where lack of electricity is to be expected in the mid to long term period. Lignite is of major significance for Kosovo as it provides direct and indirect employment for thousands of people in the lignite mining and electricity generation industry.

There are ongoing plans in Kosovo to extend the country's lignite-mining operations and install new high-capacity power plants. This will inevitably have a negative effect in the environment. Considering the extent to which the power plants have taken on the environment, the planned installation of new capacity must go hand-in-hand with efforts to improve the current environmental situation. It is self-evident that Kosovo cannot build a bright future without developing its energy sector. As Kosovo is rich in lignite, it is right way that the country relies on this resource for its future development. The following work examines the possibilities for this development path, while providing an in-depth analysis of strategic developments in short, medium and long term view. More precisely the research suggests that Kosovo would face existing environmental problems; problems in energy, agriculture, and rural development; the nature of the decision-making and discussion, providing projections for the environmental impact of Kosovo's new Thermal Power Plants (TPP), assessment of the prospect of inter-sectorial constrain, discussion of the economic scenario, potential impact on environment and spatial planning. In the mean time, my duty was to select the most effective scenarios for future developments in energy production from lignite; having in mind that Kosovo as a small country must avoid potential constrains in mining areas and trying to do the

best in saving infrastructure and other populated zones. In that sense, it was tried to involve in different scenarios all possible factors that could play a role for the energy production in Kosovo for next 80 years.

In the first stage, the structure of this work includes the methodology and the approach for this study, and it is followed by elaboration of the energy production from lignite in Kosovo. It is elaborated during the work domestic and regional energy demand and accordingly proposed the possible strategy scenario for energy sector in the land of Kosovo.

1.1. Work Methodology

This work is a product of a long personal involvement in the mining and energy sector in Kosovo, and it is based on different studies. In fact, this is a continuation of my research made during my magister study at Technical University of Freiberg. Most of the data and sources are used from the studies related to the mining and mineral sector in Kosovo and the development of several energy sector scenarios for Kosovo. According to that, the methodology used provides a large number of data and details for lignite basins that are located in Kosovo, and describes shortly the wide range of mineral resources that are feasible there. Also during the research a lot of time is spent in field exploration and analysis. During the study all efforts are made to find and analyze all the lignite fields that are important as energy resources in Kosovo and according to that to categorize those fields depending on their role and significance for further development in that sector. Based on those details the possible fossil fuel energy resources are divided as: high importance areas, medium importance areas and low importance areas.

These areas are classified through large analysis of all different parameters including the total area use, quality and quantity of fuel, settlements, quality of fuel, infrastructure, space and environmental issues and finally economical value. In these areas there are more than 12 billions of lignite and below are defined in detail also the geological formation, structure, hydrogeology and other important facts about this. Primary focus was to secure that the population will be the main beneficiary and purpose is to minimize resettlements, avoid any damages in those natural and water protected areas. That being said, there has been collected data from different sources such as municipalities, government and agencies, and have been studied in details spatial planning for such areas with the main focus on road infrastructure, water protection and resettlements. Further, are elaborated the possible areas for the building of new TPP in short and middle term period and also gave the recommendations for the steps behind that. The review of the impact of the mining operation on the environment has been carried out considering past damages and future effects of the mining operation. Measures to minimize the future effects of the mining operation like dust and noise emissions, water pollution and resettlements have been planned. The recultivation of the outside dumps can be carried out at reasonable efforts and costs. However, special attention must be paid to the mine fires, which cause environmental problems (air pollution), safety problems in the mines and an economic damage on the deposit.

The use of lignite can prompt a variety of constrains, and therefore proper strategic planning is the only mean through which constrain interests among stakeholders can be effectively reconciled. Management of strategic development and utilization of resources must be based on the objectives, standards, and criteria

that provide not only one development scenario, highlighting positive and negative impacts in each and every case. Despite its effect on spatial and economic development, the use of lignite in Kosovo has to be evaluated also as strategic resource for the country. In each alternative it is considered and proved to minimize potential of constrains, limitations and risk factors and based on those results are built the scenarios and field ranking. Specifically we have dealt with each constrains and limitations, as well taking into account the positive impacts of mining and generation activities for well-being of the country in future. The inquiry of the diminishable amount available in the single mining panels of lignite is necessary at first for specific information which is given through a relation by constrain size to the diminished amount of lignite. In connection with the certain constrain surfaces in the dismantling areas, the following specific values could be determined in specific working steps such as geological-mining, economic, environmental, spatial and social factors that specifically include analysis about:

- Total Area Utilization [km^2]
- Geological Lignite Resources [Mt]
- Mineable Resources [Mt]
- Estimated Average Geological Stripping Ratio [m/m]
- Average Calorific Value [kJ/kg]
- Corresponding Size of Power Plant [MW]
- Inhabitants/ Number of affected inhabitants per MT of lignite
- Regional dispersion of lignite resources from actual mining-distance [m]
- Water availability
- Economic Impact-number of possible employees by future openings of new mines
- Extraterritorial jurisdictions of communities{ Ha]
- Highways and railways (m)
- Regional and local road (m)
- Distance of lignite from PP (m)
- Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)
- Natural protected areas(Ha)

For the lignite utilization and proper strategic planning Kosovo mining fields are grouped and classified concerning those examined constrain potentials and based on the certain specific values. Then assessment points are assigned to the single groups, so that a minimum constrain potential proves a maximum score. The essential meaning in this connection has the specific resettlement, followed by protective areas and infrastructure. The weighted assessment points are added up and the results are put together in form of a final score in a ranking list. Moreover, in parallel the stated mining fields are evaluated

also based on quality and quantity of the fuel. For short term fuel fields since they are partially under excavation and part of them under preparation for excavation and mostly poor in constrain, those areas are evaluated based in short term demand for fuel production depended of different development scenarios in the energy sector.

1.2. Country Background

Kosovo is a landlocked Democratic Republic with an area of 10,887 km^2 who is centrally located in the Balkans and boarded by Albania, Macedonia, Montenegro and Serbia. Kosovo is the youngest country in Europe who has declared its independence at 17th of February 2008. Topographically, Kosovo comprises a flat basin ringed by high mountains on all sides. The population of Kosovo is approximated to 2milion inhabitants where almost 1/3 ids living in capitol Pristina. Almost 90% of the population Albanians, the rest are Serbs (6%), Bosnians (3%), Roma (2%), and Turks (1%). Official Languages are: Albanian and Serbian, but in some regions as well Bosnian and Turkish are used. Kosovo is independent and sovereign new country, with country GDP approximated to EUR 3.434 billion (2008) where the main activities are concentrated in agriculture, mining and micro-enterprises. Most important trading partners EU – 47%, Albania 27%, Macedonia 10% and the rest of the World – 32% (2008). Below is presented the location in the regional and world context.

1.3. Geography of Kosovo

Kosovo is situated in the central part of the Balkan. In the Southwest, it is bordered by Albania, in the West by Montenegro in the North and in the East by Serbia and Southeast by Macedonia. The territory extends within longitudes 41° 50' 58'' and 43° 15' 42'' and within latitudes 20° 01' 30'' and 21° 48' 02''. Kosovo covers a surface area of approx. 10,900 km² and is characterized by an average altitude of 800 m above sea level, but showing vertical changes of relief and morphology. These morphological changes are a consequence of the geological setting. The lowest point of Kosovo is located at an elevation of 297 m (Drini i Bardhë at the border to Albania.) The country rises up to the highest point in the South of Kosovo – Gjeravica at 2,565 m. From the geographical point of view, Kosovo can be subdivided into two large regional flat units:

- the north-eastern part is referred as "Rrafshi i Kosovës",
- the south-western part known as "Rrafshi i Dukagjinit".

They are characterized by special climatic-geographical conditions. For instance, several subunits like Drenica, Artana and Gollaku, Fusha e Kosovës, Fusha e Moravës, and Podujevë are distinguished. The border between Rrafshi i Dukagjinit and Rrafshi i Kosovës forms the surface water divide between the Adriatic Sea on the one side and the Black Sea and Aegean Sea on the other side [45].

Kosovo is surrounded by several high mountain ranges. The northern part is occupied by the Kopaonik mountains (above 2,000 m), which are characterized by abrasive activity, both fluvial and glacial. In the southern and south-western part of Kosovo, Mali i Sharrit is located (above 2,500 m) at the border with Macedonia. The western part of Kosovo (border to Albania) includes parts of the Albanian Alps Mountains and the Mokra Gora Mountains (border to Kosovo).

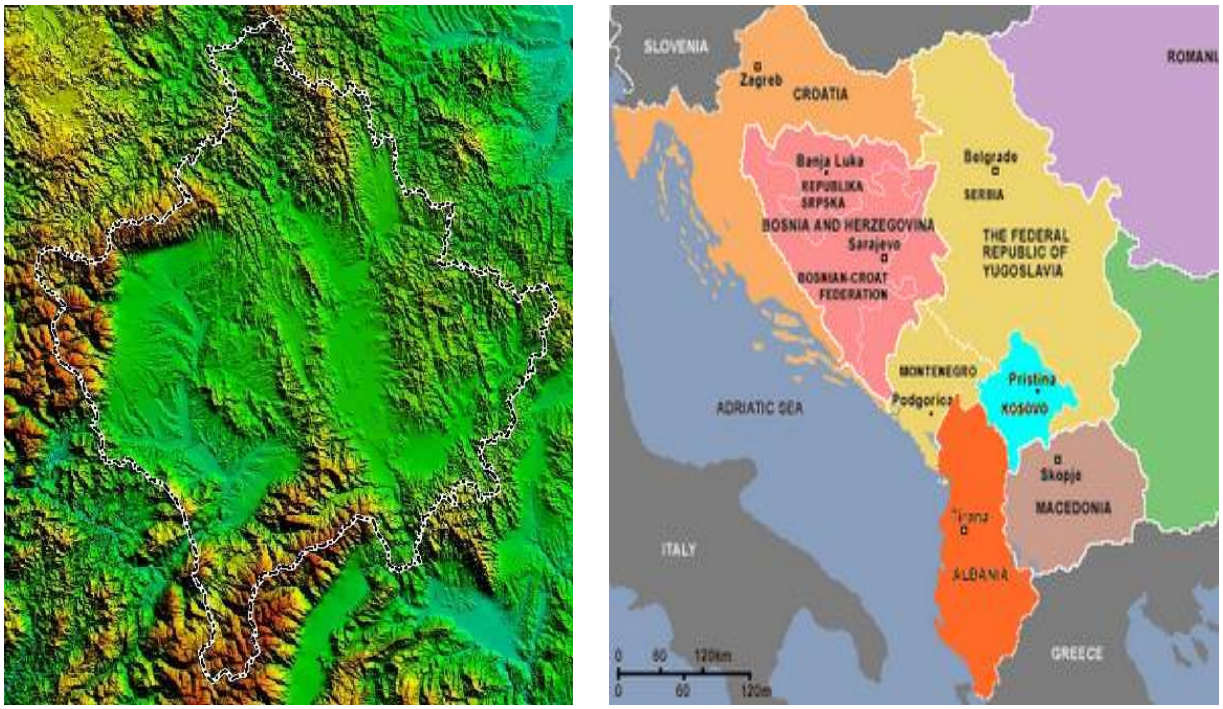


Figure 1-1. Kosovo location in south Eastern Europe and Elevation model of Kosovo [25]

These areas are characterized by rocky material, high mountains and deep gorges. In the central part of Kosovo, western and north-western of Prishtina, the mountains Bjeshket e Çiçavices, Golesh and Carralevë are located, which are characterized by carstic forms, both fluvial and abrasive, rising to elevations of about 1,000 m. The part of Kosovo, which is characterized by far flat areas, covers a surface of approx. 36 % of the territory. These basins are characterized by elevations between 400 and 700 m above sea level.

1.4. Economical Situation in Kosovo

Kosovo has one of the most under-developed economies in Europe. According to the World Bank (WB), the average annual growth rate of real GDP between 2002 and 2006 is estimated at less than one and half % with increase in recent years after the declaration of independence in February 2008. Most economic development since 1999 has taken place in the trade, retail and the construction sectors. The private sector

that has emerged since 1999 is mainly small-scale. The industrial sector remains weak and the electric power supply remains unreliable, acting as a key constraint. Unemployment remains pervasive, at around 40-50% of the labour force. The economy was hindered by Kosovo's unresolved international status, which has made it difficult to attract investment and loans. Moreover, Kosovo continues to face challenges common to all fragile states; huge backlog of investment needs and limited government resources to meet them, fractured societal relations, and weak security. The traditional economic driver of Kosovo has been primary industry (agriculture and forestry, mining and energy generation), with manufacturing providing a minor contribution to the generation of wealth. Some 30% of GDP is provided by remittances from the Diaspora (mainly in Germany and Switzerland) who account for 20% of Kosovo's pre-1999 war population. Over 65% of the working population resident within Kosovo is employed within the agricultural sector. Formerly a net exporter of foodstuffs, Kosovo now has a large negative trade balance in this sector, with food products being the largest single import segment, accounting for 30% of imports by value [37].

Apart from the mining of lignite by the energy provider, Kosovo Electricity Co (KEK), and the extraction of construction minerals, the formal mining sector has stagnated since the 1999 NATO intervention. The two former national icons of the mining sector (Trepca and Ferronikeli) ceased production in 1999 and only Ferronikeli has taken active mining operation since 2007. Recently well recognized mines of Trepca are trying to activate some of capacities and they are producing row materials for export. The energy sector in Kosovo is considered to be in a critical situation. The existing electricity production and supply systems have suffered from many years of underinvestment, and they cannot meet present and future anticipated demand. There is no reserve capacity, and power outages are frequent at peak demand periods as well as when there are unexpected technical failures in the system. The government is forced to allocate funds to cover the cost of imported electricity in an attempt to meet demand during the winter months.

Kosovo's minerals sector was a key provider to the economy of the former Yugoslavia. The geology of Kosovo is varied and has resulted in a wide range of minerals being present in mineable quantities. These include lignite, lead-zinc, silver, nickel, chrome, aluminium, magnesium and a wide variety of construction materials. Mismanagement and underinvestment, as well as the political developments in former Yugoslavia that resulted in NATO intervention, have had a dramatic and negative effect on Kosovo's mining industry and on the amount of metals produced throughout the region. This emphasizes the major role that Kosovo played in the economy of the former Yugoslavia as a provider of raw materials.

1.5. Exploration Potential of the Country

Geological prospect in Kosovo should be viewed as being extremely high. Although there is a mining history that dates back to pre-Roman times the recent technological advances in mineral exploration have not been systematically applied in Kosovo. The use of remote sensing and geophysical prospecting techniques aimed at discovering deposits have yet to be applied. There is no systematic geochemical survey data (soils, stream sediments) available, and lots of drilling records were lost during the 1999 war

The complex geological history of Kosovo, coupled with the lack of systematic mineral exploration activity (such as at the five Trepca mines where the full extent of the mineralization has not been tested by drilling), indicate high perspective. The application of systematic exploration programmes in the new climate of direct foreign investment from the global mining sector should yield exploration successes to rival those of neighbouring countries [37, 29].Proven exploration potentials exist for lignite, lead, zinc, silver, nickel, chromium, bauxite, magnetite, and construction minerals (hard rock, gravel, sand, clay). Several indications of precious metals (gold and platinum) were detected in rivers and as accompanying metals in other ores (chromate and base metals).

1.6. Geology of Kosovo

Kosovo has a varied geology that ranges in age from the Neo-Proterozoic to the Holocene. The geology is characterized by substantial structural features on a regional scale, including normal faulting and thrusting. A general simplification of the stratigraphic sequence is as follows.

- Holocene scree ormed from weathering of mountains and alluvium deposited by the rivers.
- Pliocene: andesitic chert
- Upper Miocene-Pliocene: formation of lignite from the accumulation and subsequent decay of vegetation in sedimentary basins.
- Oligo-Miocene: conglomerates, clays and limestone, accompanied by acidic to intermediate magmatism.
- Late Cretaceous 'molasse': shallow-water carbonates and clastics.
- Upper Cretaceous 'flysch': marly limestones, sandstones and conglomerates.
- Early Cretaceous: conglomerates, sandstones and silts.
- Late Jurassic: massive limestones.
- Triassic-Jurassic: basic and acidic magmatism, and associated ophiolitic crustal rifting and abduction of ultra basic rocks.
- Triassic: clastics with volcanics giving way to carbonate platforms that grade up into dolomites, some of which have been metamorphosed to marble.
- Permo-Triassic: carbonates, clastics, phyllite, schists and quartzites that have been invaded by acidic magmatism (quartz porphyries).
- Late Palaeozoic: schists.
- Neo-Proterozoic-Palaeozoic: basement of schists, gneisses and amphibolites that have been invaded by granitic plutons.

The oldest rocks form the Neo-Proterozoic basement, which is composed of crystalline schists and granites, representing the products of regional high-grade metamorphism. These rocks mainly outcrop in the northeast of Kosovo.

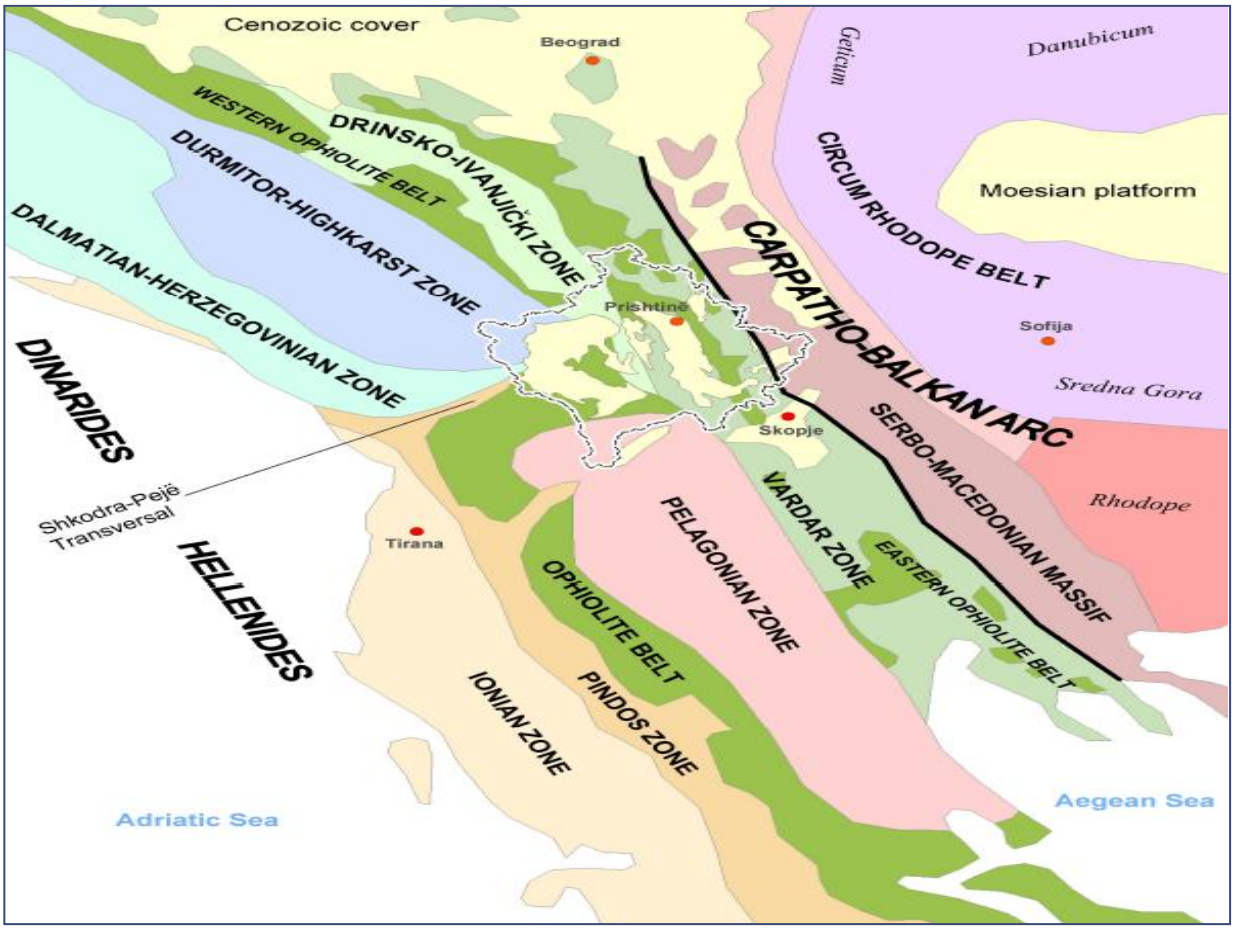


Figure.1-2. Geological map of Kosovo [45]

Laid down on top of this continental basement was an extensive sequence of shallow water marine sediments (clastic and chemical) of Late Permian to Early Triassic age that were invaded by acid magmas as the continental crust thinned, resulting in the anatexis of pre-existing rocks. Continued stretching and thinning led to physical separation of the continental crust, resulting in the extrusion of basalt, hosting highly irregularly shaped pods of high-grade chromate [45].

This separation was extensive enough to lead to the formation of the Para Tethys Ocean that ran across the Balkans, including Kosovo. The Para Tethys was a branch of the main Tethys Ocean that ran across southern Europe, the Mediterranean and North Africa. A reversal of tectonic plate movement led to the eventual closure of the Mesozoic-age Tethys Ocean, including a segment called the Vardar Ocean (Para Tethys) across Kosovo [24].

By late Jurassic times, the presence of a remnant Vardar Ocean as a shallow sea led to the chemical deposition of thick and extensive carbonate platforms. By Cretaceous times, the eventual retreat of this sea and the stability provided as a passive continental margin, led to the deposition of clastic sediments that range from marine to terrestrial in origin. Collision between the landmasses that had flanked the Vardar Ocean forced the westward abduction of remnants of oceanic crust upon continental crust.

The result is the remnants of oceanic crust found throughout the Balkans, forming linear ophiolitic sequences aligned along the regional NNW-SSE (northnorthwest-southsoutheast) regional structural trend. These abduction events are polyphase and would appear to represent crustal accretion, resulting in the development of several linear belts of ophiolites, ranging in age of abduction from Jurassic to Cretaceous.The rocks that were over-thrust during the emplacement of ophiolites are called the 'sole'; rocks and form units called mélange. Such ophiolitic mélanges are characteristically composed of chert, serpentinite, mafic volcanics and carbonates, all of which may be in the form of fragments within chaotically sorted olistostrome units. In Late Cretaceous times, extensive continental collision during the Alpine Orogeny led to the formation of the Alps and associated mountain ranges throughout central and southern Europe. The rapid erosion of these contorted rocks of both marine and continental origin resulted in the deposition of the flysch cover sequence, composed of marly lime stones and clastics. As the Alpine Orogeny waned, so the young mountain ranges were eroded to produce the continental molasse cover sequence that formed predominantly in intermountain basins throughout the Alpine Zone. Some of the continental clastic sediments preserved in Kosovo probably represent molasse deposits. Basin depressions within Kosovo were sites of luxuriant vegetation growth that finally became overwhelmed by sedimentation and led to the formation of the substantial stratiform lignite deposits that are mined by KEK. The Pleistocene glaciations that affected Europe removed much of the soil cover from Kosovo's ring of surrounding mountains, leading to the formation of substantial talus deposits along the steep mountain flanks

1.7. Hydrology of Kosovo

There are many rivers in Kosovo, which flow toward the Adriatic Sea, the Black Sea and the Aegean Sea. The main rivers in Kosovo are: Drini i Bardhë (in the southern part of Kosovo flows into the Adriatic Sea), Lumi i Ibrit (in the north-western part, flows into the Morava and Danub and further into the Black Sea) and Lepenci river (in the south-eastern part, flows into the Vardar-River toward the Aegean Sea).More interesting, the Black Sea is drained by water from a surface water catchment area of 5,500 km², or 51 % of the Kosovo territory, the Adriatic Sea is drained by an area of 4,500 km², or 43 %, and the Aegean Sea is drained by an area of only 900 km², or 6 %.The watersheds of the three main drainages (Drini i Bardhë, Lumi i Ibrit and Lepenci) are touching each other approximately 16.5 km west of Ferizaj. At this contact point of the three watersheds, the mountain Drman is located, reaching an elevation of 1,359 m above sea level. From here, the surface water flows towards the Adriatic Sea, the Black Sea or the Aegean Sea. Other important rivers in Kosovo are: Sitnica, Morava, Bistrica e Pejës and Bistrica e Deçanit. Kosovo does have

a large number of karst springs, thermal and mineral water springs, glacial valleys and lakes and artificially made lakes.

River	Surface (km^2)	Qmin (m^3/s)	Qmid (m^3/s)	Qmax (m^3/s)
Drini i Bardhë	4657,88	10,47	60,49	591,00
Ibri	493,04	5,93	33,08	300,07
Morava	1860,00	1,34	7,26	119,40
Lepenci	697,60	1,64	8,19	78,90

Table 1-1. Most important rivers in Kosovo [7]

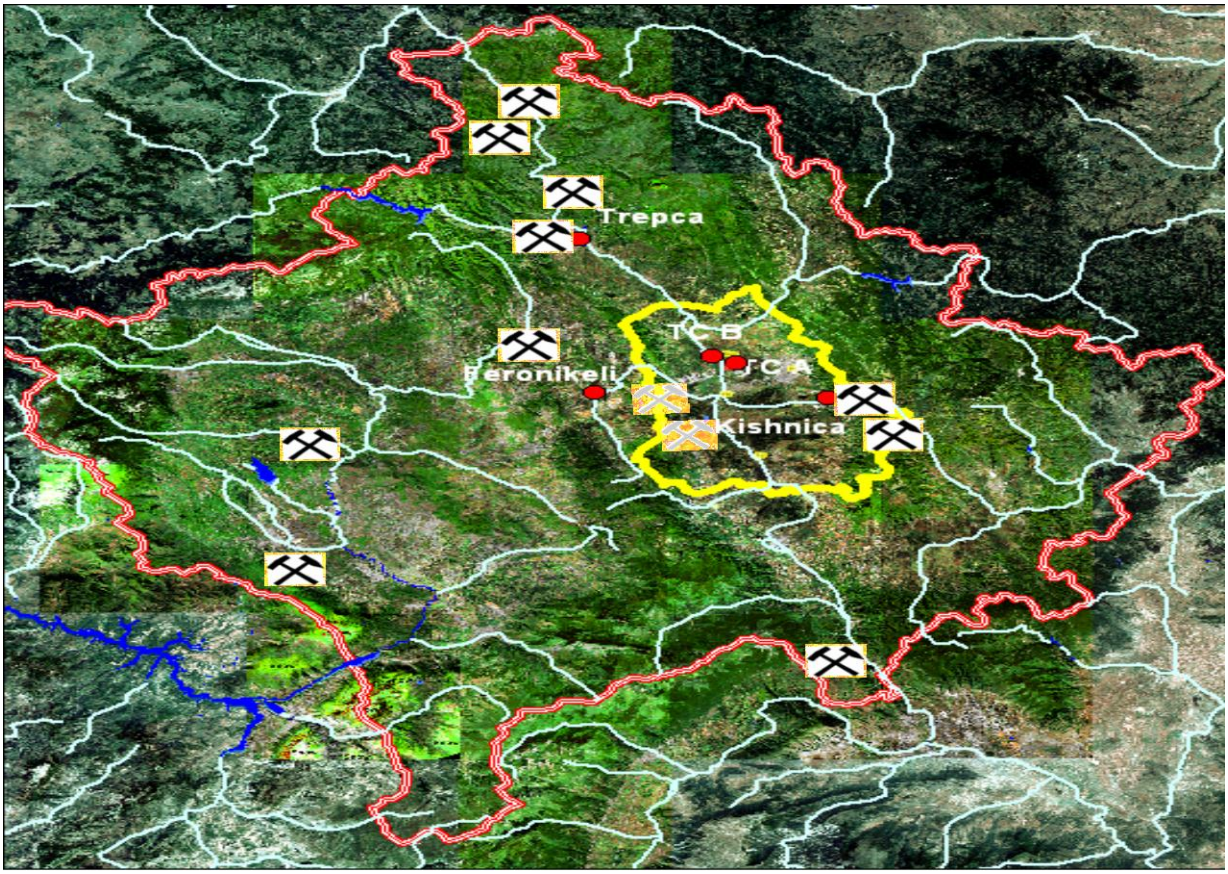


Figure 1-3: Hydro geological map and main mining activities of Kosovo [7]

1.8. Infrastructure of Kosovo

The country's infrastructure is under development. A fully developed road network does not exist, however in general, the roads are within acceptable conditions. There are several main roads connecting the large towns of Kosovo and its territory with the neighbouring countries. There are railway tracks to Macedonia and Kosovo, but the railway system does not operate regularly at the moment. Regular international air links are provided from across Europe to Prishtina, the capital city of Kosovo.

Figure 1-4: Infrastructure of Kosovo [23]

Chapter II

2. MINERAL RESOURCES IN KOSOVO

2.1. Ongoing Developments in Mining Sector

Although economic development based on extensive exploitation of natural mineral resources does not present a kind of advanced economic development, in current circumstances of trade deficit and long-term stagnation in industrialization, recommencement of intensive exploitation of natural resources that Kosovo possesses would be an important impetus and a chance to reverse the present negative GDP and foreign trade trends. Advantages upon which the strategy of renewal and development of Kosovo's industry can be built up are: possession of considerable own mineral and lignite resources, objects' buildings mostly not damaged, and domestic and foreign market able to absorb respective products produced in Kosovo.

Currently, the mining sector does not play an important role in economic development of Kosovo as used to play during the past years, especially before Kosovo's autonomy was abolished by force and Kosovo was occupied. Beside the fact that the slowdown in the development of this sector has caused a decrease of the corresponding participation in Kosovo's GDP, this slow down resulted also in a considerable decrease of the number of workers employed in mining sector compared to the situation before the autonomy of Kosovo was abolished. It is understandable that this decrease resulted in an increase of poverty of the mining community, accompanied by numerous problems. Regarding development aspects, actual situation of mining sector can be characterised by a number of specific features, depending on mining nature, respectively on the type of minerals excavated from those mines. In this aspect, following are the types of mine present in Kosovo:

- lignite mines,
- lead and zinc mines, ferro-nickel, magnesium,
- bauxite and chromium mines, and
- artisan mines of construction materials

2.2. Mineral and Energy Resources of Kosovo

Kosovo is endowed with considerable mineral resources, especially lignite, as well as important deposits of lead, zinc, nickel and magnezite. Geologically the territory of Kosovo is part of the Tethyan Eurasian

Metallogenetic Belt (TEMB) that was formed during Mesozoic and post-Mesozoic times in the area of the former Tethyan Ocean on the southern margin of Eurasia, with the Afro-Arabian and Indian plates to the South. It extends from the western Mediterranean across the Alps and south-eastern Europe through the Lesser Caucasus, the Hindu Kush, and the Tibet Plateau to Bourma and Indonesia, linking with the West Pacific Metallogenetic Belt.

The Carpathian-Balkan region is one of the sectors of the TEMB, characterized by some specific features. The development of ore deposits and regional metallogenetic units is associated with specific tectonic settings within the individual sectors of the TEMB. Based on plate tectonic concept it is possible to distinguish between: Intercontinental rifting (iron-oxide skarns associated with hypabyssal intrusions, volcanogenic, hydrothermal and volcano-sedimentary deposits related to volcanic/sub volcanic activity, containing Pb, Zn, Ba, Hg, Fe, Mn, low temperature deposits located along continental margins and represented by carbonate hosted Pb-Zn sulphides and Hg). Mineralisation associated with ocean-floor spreading areas (associated with ophiolite series, particularly inside the Dinaride mountains, the following should be mentioned: chromites, Ni-Co-Cu sulphides (pyrrhotine-chalcopyrite-pentlandite-magnetite in association with Au and Ag, titanoferrous magnetite and pyrite-chalcopyrite occur in gabbros, volcano-sedimentary deposits with pyritic copper sulphides and bedded ferromanganese deposits).

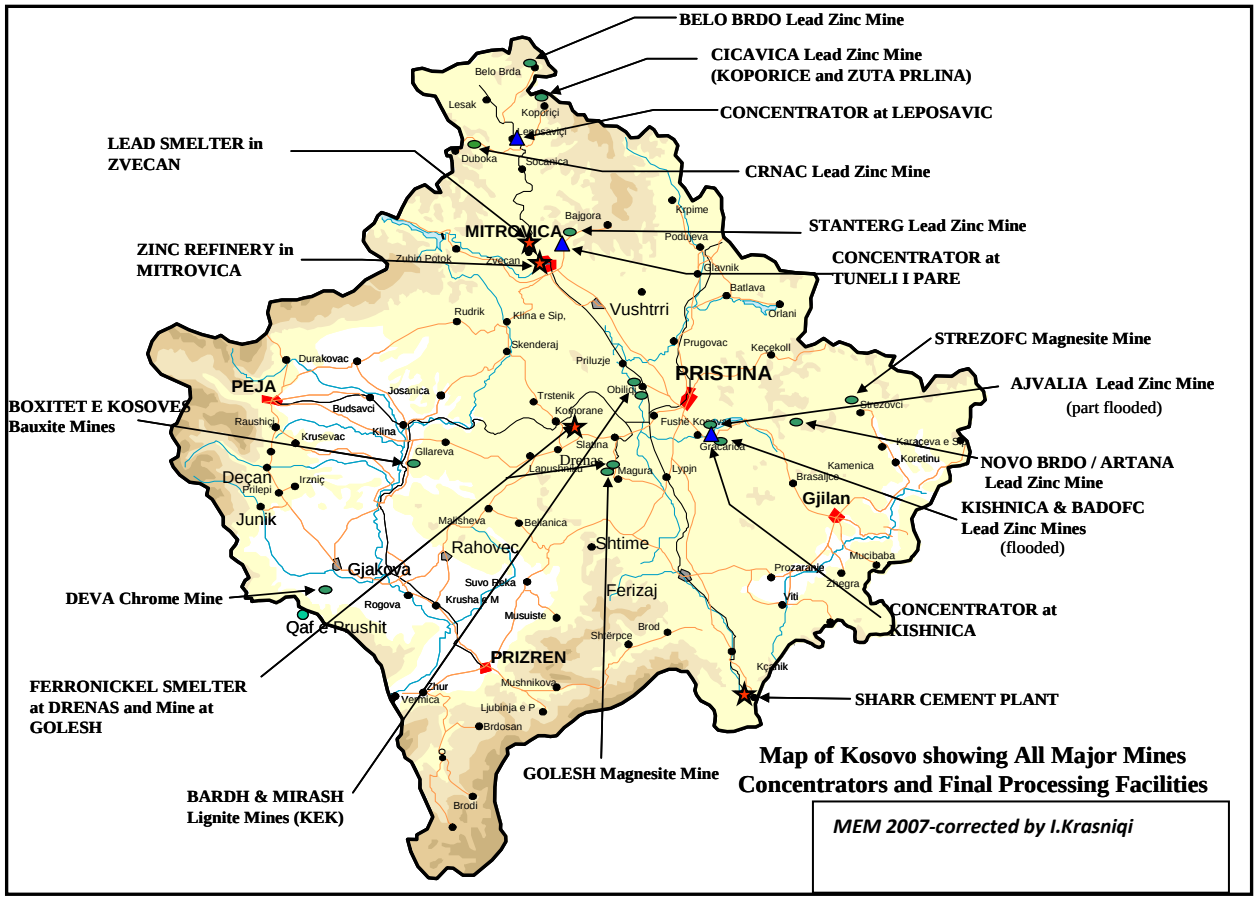


Figure 2-1. Map of Mineral Resources of Kosovo

Kosovo's raw material resources for power production are relatively high in comparison to the respective European and World averages. This is particularly true for lignite reserves. Exploitable reserves are assessed to be about 12-14 billion ton or about 5.850 t per capita, what represents an average much higher than European's average. Reserves of lead and zinc minerals belong also among the biggest in Europe and wider.

2.2.1. Lignite Resources of Kosovo

Lignite is of outstanding importance in Kosovo. It contributes 97% of the total electricity generation, with just 3% being based on hydropower. Kosovo possesses the world's fifth-largest proven reserves of lignite. The lignite is distributed across the Kosovo, Dukagjini and Drenica Basins, although mining has so far been restricted to the Kosovo Basin. The first systematic records of lignite exploitation date from 1922, when small-scale, shallow underground room-and-pillar mining commenced in the Kosovo Basin. Large-scale winning of lignite began with the first production from the Mirash (1958) and Bardh (1969) open-pit mines, using bucket wheel excavators.

Cumulative exploitation from the commencement of mining in 1922 up to the end of 2007 has amounted to 283 Mt. Geologically, Kosovo's lignite mines exploit one of the most favourable lignite deposits in Europe. The average stripping ratio is 1.7m3 of overburden to one tonne of lignite and the total estimated economically exploitable resource represents one of the richest in Europe, which would allow ambitious power generation and expansion schemes in forthcoming decades.

Lignite Reserves (Mt)			
Basin	***Surface (km²)***	***Investigated reserves***	***Exploitable. reserves***
Kosovo's	264	11.500	9.804
Dukagjin's	95	2.700-	1.625
Drenica's		87	74
Total		14.324	11.503

Table 2-1: Lignite reserves in Kosovo [38, 2]

The lignite is of high quality for the generation of electricity and compares well with the lignite resources of neighbouring countries on a range of parameters. Kosovo's lignite varies in net calorific value (NCV) from

6.28-9.21 MJ/kg, averaging 7.8 MJ/kg. The deposits (Pliocene in age) can be up to 100 m thick, but average thickness is 40 m, and possesses an average strip ratio of 1.7:1.

2.2.2. Lignite mines in Kosovo

The combination of favourable geological conditions and good quality means that the cost of lignite-fuelled electricity production in Kosovo is the lowest in the region. Further development of lignite mining in the medium term will continue with the exploitation of the Siboc mining field in the northern part of the Kosovo Basin, and provides a great opportunity for private investors. Lignite mines are currently seen as mines of the greatest interest for the development of Kosovo's mining sector. The reason for that is based on huge lignite deposits by which Kosovo is endowed and on the permanent increase of electric energy prices in the world. Current challenges related to the opening of new lignite mines are interlinked with the plans for building of a new power plant with a capacity up to 2,100 MW. The ongoing development policies in mining sector are mainly concentrated in opening of a new mine in the South Siboc.

Figure 2-2: Lignite mines and PP in Kosovo [1, 2]

Exploitation of lignite from this field is planned to be carried out in two phases: opening of a new mine in the southern part of the Siboc field for fulfilment of the needs of "Kosovo A" power plant until its closure foreseen to happen by 2017, as well as of the needs of "Kosovo B" power plant until 2027; extension of opening of the new mine in the rest part of the Siboc field for fulfilment of the needs of the new "Kosovo C" power plant, with a capacity up to 2,100 MW, for a period of 40 years.

2.3. Regional Economical Integration and Comparative Advantages of the Country Regarding the other Neighbours

Kosovo's economic prospects are brighter if it continues on its path of integrating its economy with others in the region. The large ethnic Albanian populations in the Republic of Albania, Macedonia, Kosovo, South of Serbia and Montenegro make available informal channels for investment and trade. These will strengthen naturally the national connections. Kosovo has some of the largest lignite reserves in Europe. The primary opportunity for substantial capital investment that would produce significant export revenue for Kosovo is in the energy sector, given the need to build new mine and electric generating capacity to take advantage of these reserves.

Kosovo still is a predominantly agricultural economy, with most agricultural production taking place on small family-owned or village-run subsistence farms. Substantial reform in the methods of farming would be necessary for Kosovo to become a significant exporter or even to be self-sufficient—in raw agricultural products. Agricultural processing, on the other hand, is a significant investment opportunity. Already wine production, soft-drink and beer processing and bottling, and dairy-product processing have attracted significant foreign investment [37].

Tourism is a largely untapped opportunity for Kosovo. Its geography is beautiful, varied, and largely unspoiled. A state-of-the art ski resort operates in southern Kosovo. Hotels and restaurants in the cities are of high quality. Those features, combined with Kosovo's history and prominence in the news, present the possibility for attracting a significant number of foreign tourists. Investment in tourism is attractive because of large job-creation potential, relatively low capital costs and the opportunity to earn significant foreign exchange. Kosovo's good internet infrastructure, the large number of young professionals with good information-technology skills and the now widely recognized potential of e-commerce to allow small enterprises access to world markets represents another largely-untapped opportunity.

2.4. Possible Economic Development Scenarios

Present energy demand in the industrial sector is low, reflecting the low performance of the Kosovo economy. The main drivers in the energy demand projections are the development in the economy (measured by GDP) and the increase in size of population.

Due to the complexities and uncertainties linked to the development of the Kosovo society and economy, a forecast for the economic and demographic development has been based in assumptions and prognosis. As basis for the economic and energy forecasting, three scenarios have been considered:

HGS: High Growth Scenario with an average GDP growth of about 10 % per year;

MGS: Medium Growth Scenario with an average GDP growth of about 6% per year;

LGS: Low Growth Scenario with an average GDP growth of about 4% per year.

The demographic structure, its distribution and growth in Kosovo is subject to many discussions. Though the exact numbers are difficult to estimate, there is little controversy over the observation that the recent population growth rate has been among the highest in Europe. It is assumed that the historic growth rate of the previous decades (above 2% p.a.) is already rapidly declining. In addition considerable migration makes forecasting difficult. In all three scenarios the population is expected to grow 1.5%/anum, from 2.1 million in 2008 to 2.54 million in 2015. The present average household size is estimated to be 5.38 persons for 2008 and approximately 370,000 households. This is expected to fall as new dwellings are erected and more regular European family patters emerge in Kosovo. Ensuring Kosovo is open for business and economic development means we must confront our greatest economic challenges: energy and infrastructure. Kosovo consider energy as the greatest impediment to economic growth and stability [31].

Kosovo has to create the necessary infrastructure for the private sector to enter into the energy market, build new power generating capacities, supply consistent energy to our people and be a regional exporter of energy. There must also be studies for the viability of alternative sources of energy to meet current demand. The entire world is now grappling with the question “where will we get the energy to power the global economy of the 21st century without causing irreparable damage for nature and environment?” Kosovo with its large resources is a place where that defining question is answered and Kosovo has a chance to be regional centre for clean energy production with modern technologies, renewable energy research, energy product development and job creation. All this has to support the economical growth and social welfare of Kosovars.

Chapter III

3. VALORIZATION AND STRATEGIC MANAGEMENT OF THE ENERGY RAW MATERIALFOR SECURE ENERGY SUPPLY

3.1. Role and Importance of the Energy Raw Materials

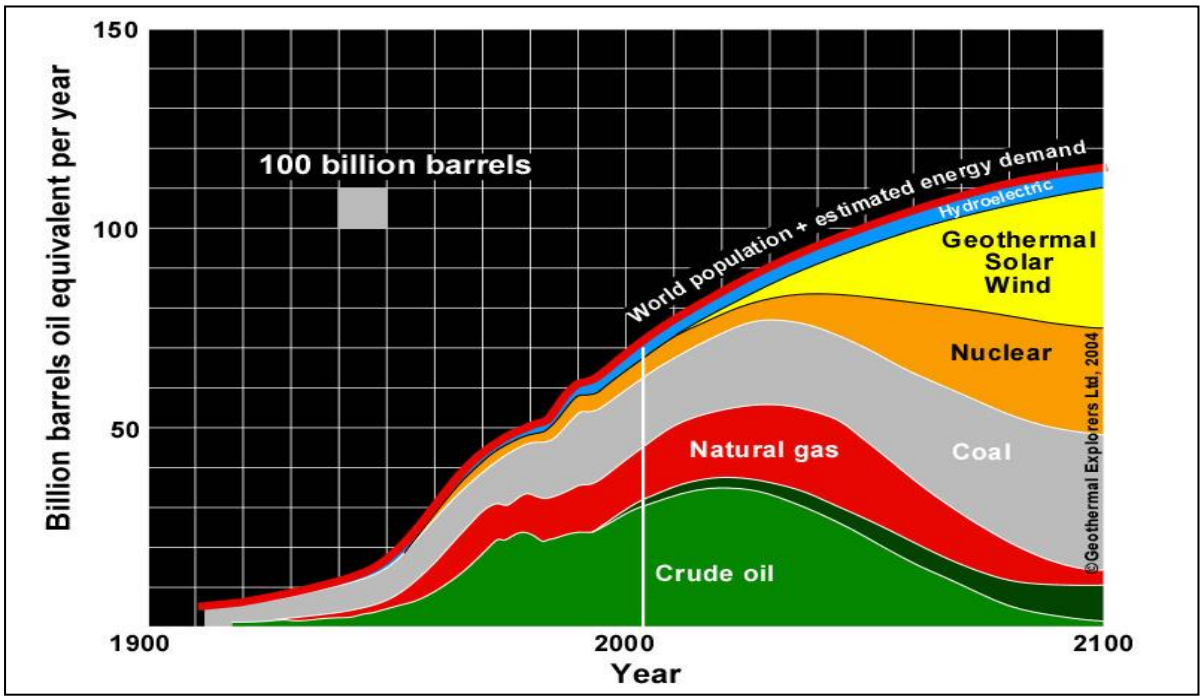
A secure energy supply puts the world economy in the 21-st century before a big challenge. A continuous growth in population, a rising power demand, caused by increasing industrialization as well as the critical political position in some of the most significant resource lands complicates a strategic care of the world with energy. The effectiveness ours today's society is tied together on the other side inseparably with a continual and reliable energy supply. What big consequences a failure of this care can entail, could be observed in younger past during the strom failures in North America (August, 2003) and Europe (November, 2006), although it concerned, on this occasion, only short-term and on the regional level restricted disturbances. From big meaning for the global energy supply are the fossil energy sources, oil, and natural gas. There the mineral raw material uranium comes as a source material for the power production in nuclear power plants. An application of renewable energy as for example wind strength, photovoltaic, geothermal and biomass contributes to a more decentralized and more adaptable energy supply and will show in future a valuable supplement. Indeed, remains to stick, that regenerative energy only irregularly can be won and in comparison to utilization from fossil energy sources reach only low efficiency degrees, so that a solution of the energy problem is not to be expected by the application of regenerative energy for foreseeable time. A well-balanced energy mix must fulfil in the essentials three energy-political purposes care security, economic efficiency and environmental compatibility, around a lasting fulfilment of the needs of economy and society.

3.2. Worldwide Developments of the Energy Consumption

The worldwide primary energy consumption lay in 2005 with 15.047 Mt SKE. Compared with the year before an increase is to be ascertained with it about 2.7%. The following illustration describe the primary energy consumption divided in the energy sources oil, natural gas, lignite, nuclear energy and other energy sources (renewable energy, primarily water power).

Primary energy consumption is growing very fast and this is shown in figure below. Here also is specified that with an interest of 36.8% in the primary energy consumption (without biomass) oil is the most

significant energy source. In 2005 3.895 Mt of oil were extracted worldwide. The most important producers of oil were the Middle East, North America and Russia. With the expectation that of "depletionn midpoint" is reached for conventional oil during the next 10 to 20 years this raises the importance of other fuel resources to ensure the energy for future. In this case for the strom production, lignite with 37% is even the most significant energy supplier for future.



Graph.3-1: World energy consumption forecast for this century [46]

To different types of lignite are the contributors for energy production and the differences are based in the heat value of the respective lignite. Lignite with a heat value, above a limit value of 16,500 kJ/kg lies it is called hard lignite, if the heat value lies below this limit value it is known as lignite or brown lignite. While hard lignite is relatively insensitively compared with carriage and is traded, hence, worldwide, soft brown coal-lignite are suited primarily for the energy production close to mines and this make this resource even more important cause you are not depended to brink the fuel from somewhere and this means you have reliable resource for secure energy production. The worldwide known reserves and resources are 642 000 Mt of hard lignite and 67 000 Mt of lignite. The biggest hard lignite producers in past years were China, the USA, India, Australia, South Africa and Russia. The largest amounts of lignite are produced from Germany, the USA, Russia, Greece and Australia. Kosovo is ranked in fifth place according to lignite resources worldwide.

Natural gas is with an amount of 23.5% in the world energy consumption after oil and lignite the third-most important energy source. The worldwide reserves are estimated at 176·1012 ms ^{3} (according to a recompense of 133 000 Mt of oil). Possibly half of these reserves lie in Russia, Iran and Qatar. The biggest

producers were North America and Russia. Up to now about 31% of the natural gas reserves discovered all together was promoted. Another mineral raw material for the power production is used is uranium. The interest of the nuclear energy in the primary energy consumption lay in 2007 with 6.1%. Worldwide reserves exist at the rate of about 1.8 Mt of uranium. The known reserves lie in the essentials in Australia, Canada, Kazakhstan und South Africa. The fossil energy sources oil, natural gas and lignite will be based on the prediction most reliable energy sources by far also in 2030. Presently 63% of the energy is used in industrial states, although only 23% of all people live in these states. This relation will strongly change till 2030, because the growth in population walks along in the developing lands and threshold lands with a strong increase of the energy consumption. Thus about 47% of the energy is used at that time in developing lands and threshold lands [46, 5].

Chapter IV

4. PRIMARY ENERGY CONSUMPTION IN KOSOVO-CURRENT AND FUTURE TRENDS

4.1. The Current Situation in the Energy Sector

Energy sector in Kosovo is dominated by Kosovo Energy Co (KEK). The energy production system is composed of two lignite mines at Bardh and Mirash, two lignite power plants Kosovo A and B, with an overall effective capacity of 710 -890 MW (from an installed capacity of 1478 MW), from transmission and dispatching network, distribution network and supply. The main energy resources in Kosovo are located in two big lignite basins, named "Kosovo Basin" and "Dukagjini Basin'' with exploitable lignite reserves of good quality. There in centre of Kosovo is located also the third smaller basin ,called Drenica Basin which is not actually well explored, but this is the option for long term developments in the sector. The estimated lignite quantity is between 12- 14 billion tons and these figures are variable cause in different studies there are different data.

Kosovo lignite reserves have low content of sulphur, relatively good concentration of lime (calcium oxide) that helps partial sulphur absorption during burning process and generation. The proportion between the overburden and lignite is very favourable, a fact that makes mines very attractive for exploitation.

Kosovo Lignite average calorific value is 7,800 kJ/kg, the average ash content is in the range of 14 – 17 % and the moisture varies between 42 – 49 %. Two actually operative open mines of lignite (Bardh and Mirash) operate from years 1963/64. Currently these two mines supply two existing power plants with approximately 8-8, 5 Mt of lignite per year. According to last estimates existing mines will exhaust completely until 2011-2012, which depends from the intensity of energy generation compared to the lignite reserves in existing mines.

The installed technical capacities of two power plants could have been sufficient for fulfilment of current Kosovo's demand for electricity. However, due to the lifespan and improper maintenance years before and after the war, the safety and reliability of equipment have seriously been damaged. Hence, existing available capacities are reduced significantly especially at TP Kosovo A, as is shown in the table below. Majority of the generating units at TP Kosovo A is in very weak operational condition and with small generating possibilities, as a result of failures and unexpected breaks.

The only important plants outside the KEK are two small hydropower plants (HPP) in Ujmani (2x17.5 = 35 MW), administered by the irrigation company (Irrigation hydro system Ibër-Lepenc) and HPP Lumbardhi in Deqani area with an installed capacity of 12MW. Actually total generating system capacities in Kosovo

(B1+B2, A1-A5 and two small units of Ujmani HPP), are at the level of approximately 800-900 MW with annual generating capacities around 4.800-5200 GWh. It should be emphasized that net generation during the years after the war (1999) has continuously increased.

Power Plant	Unit	Installed Power [MW]	NET Power [MW]	NET Available Power [MW]	Fuel	Start of operation
Kosovo A						
	A1	65	58	30-40	L/N	1962
	A2	125	113	0	L/N	1964
	A3	200	182	130/145	L/N	1970
	A4	200	182	120/145	L/N	1971
	A5	210	187	135/150	L/N	1975
Industrial Steam Plant		1x16 + 1x25MW = 41 MW		Not in operation;		1970
Kosovo B						
	B1	339	309	230/250	L/M	1983
	B2	339	309	230/250	L/M	1984
HPP Ujman						
	G1	17.5	17.5	17.5		1983
	G2	17.5	17.5	17.5		1983

Table 4-1: Existing Energy Power Plants in Kosovo [41]

The current technical situation of the energy capacities and their technological level does not guarantee reliable and competitive supply to fulfil the actual consumer demand, and even less the anticipated increase of demand. It must be stressed that during the last 10 years, a distinctive change of the structure

of electricity consumption among different consumer ranges has been noticed. Participation of households and services has increased from 26% to 75%, respectively the demand from industry has decreased from 67% to 12%. The electricity consumption for heating comprises 64.2% of supplied electricity, therefore creating an overwhelming burden in winter seasons. The above-mentioned situation, regarding supply in the electricity sector, has put KEK into a very unstable economical situation, with limited financial capabilities for fulfilment of its own duties. Therefore, it is of a great importance that KEK puts more efforts in order to establish effective relationships between supplier and consumers, reduction of commercial losses which means the urgent increase in billing and collection.

These are the main challenges and preconditions for immediate stabilization of energy sector in Kosovo as well as the establishment of a stable and competitive environment for investment attraction. Other problems that aggravate the situation are; lack of financial means for rehabilitation and revitalization, and current dilemmas on generating units that need revitalization and those that need to be closed down; continuous restructuring and reorganization, including corporatization, lack of staff advancement and training to increase their managerial capacities, specifically lack of young experts, long-term problems in relation to the environmental pollution and finally lack of foreign investments.

The above-mentioned problems cannot be solved without undertaking serious measures in restructuring of the energy sector in general. Restructuring of the energy sector can ensure operation on commercial basis and may facilitate competition within the energy market in Kosovo. This would enable the overcoming of the above-mentioned problems, resulting in a more efficient use of current assets of lignite and energy production.

4.2. Transmission and Distribution Network

The overall length of transmission lines (400 kV, 220 kV and 110 kV) is 1,187 km. During wartime in Kosovo, the transmission network and especially the 400 kV have been partially damaged. Majority of transmission lines have been repaired and put into function with the post-war reconstruction, whereas substations are still in very bad technical condition.

The Kosovo Transmission Network 400 kV and 200 kV level is an integral part of the regional interconnected transmission system.

The electricity transmission system is interconnected with all neighbouring systems at the 400 KV levels, except will Albania, where this connection is available only on the level of 220 kV. A new interconnection line of 400 kV with Albania is considered vital for the achievement of considerable medium and long-term exchange of electricity between Kosovo's thermal-based systems and Albania's system on hydro-based plants. One of the major issues, which require an immediate attention, is rationalization and management of overall technical and non-technical (commercial) losses, which are extremely high [47].

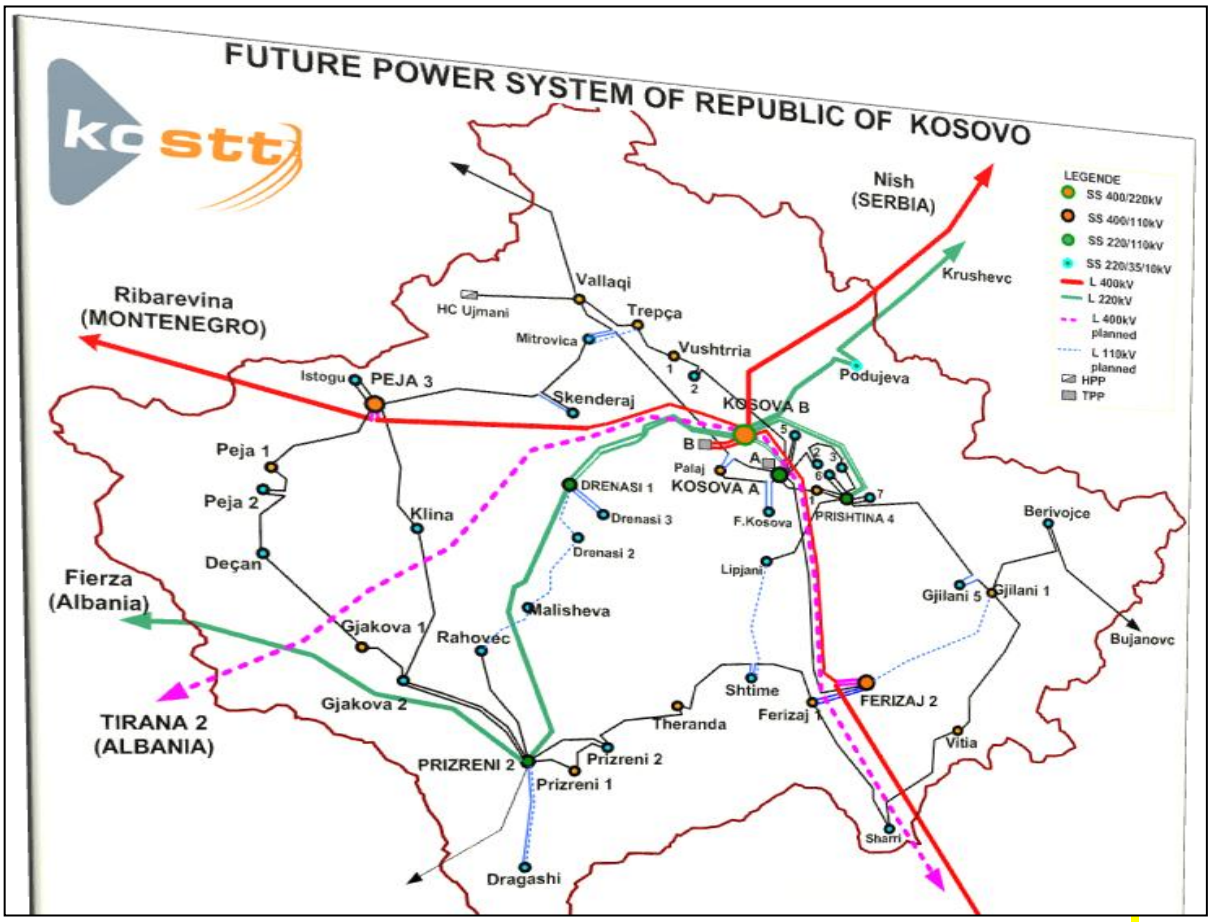


Figure 4-1: Regional transmission system of electricity and their capacity transmission [47]

4.3. Primary Energy Consumption in Kosovo

Actually the household sector is the major consumer of electricity, in Kosovo. Therefore, it is at the household level where the most intensive efforts should be made to address the consequences of limited domestic electricity production, the high cost of imported electricity, and high levels of environmental pollution from energy production and use. The pressing need for energy conservation, energy efficiency, and informed choices at the household level does not, however, easily translate into clearly effective solutions. Here also must be appointed that in future, increase of the %age of energy consumption .from industry sector has to become a priority.

4.3.1 Overall Trends in the Sector

As it is mentioned before with lack of accurate statistical data, it is difficult to produce reliable forecasts at this time. However, from the data that are available the overall energy demand trends show that

households now consume around 70 % of electricity supplied and account for approximately 50 % of overall consumption of firewood. The proportion of energy consumed by the household sector is expected to decrease in the future as a result of assumed private-sector business growth in Kosovo.

Even so, based on predicted growth in the number of households, household energy consumption for all fuel sources is expected to grow in absolute terms over the same period. It is important to note that the growth forecasts do not, in any systematic way, take into account potential future changes in consumption behaviour, including energy conservation and efficiency, and switching between alternative fuel sources. Such changes may occur in response to market prices, changing social values and attitudes, and, in the case of electricity supply, increased measures to prevent non-payment of bills and theft. This chapter is particularly concerned with those potential underlying factors as well as others that influence consumer behaviour in respect of energy choices and consumption.

Recent household energy survey is presented here with a view to gaining a better understanding of consumer behaviour and the potential for change [10]. During the period 2000-2006, the production of electric energy has increased from 1,914 GWh to almost 4,000 GWh in 2005, while the total energy available for consumption taking into account the Import/Export balance, (see Table 1-3), was 4,259 GWh in 2005, with an increase of 1,390 GWh compared to 2000.Export and import energy values reported in Table 1-3 show a consistent increase from to the year 2005; the import of energy has reached 3,610 GWh in 2005 and export energy 3,351 GWh. In 2000 these amounts were respectively 1,723 GWh and 767 GWh. The negative net balance between import and export energy has been of 259, 6 GWh (6.1% of the energy available in Kosovo) in the year 2005. In 2000 these values were 955 GWh (33.3 % of the energy available in that year). The data of 2006 are very close to those of 2005.

4.3.2. Energy Balances and Energy Forecast for Short and Middle term Period

The entire primary energy consumption of lignite, oil, gas, and wood is divided into four main energy consumer groups (conversion, residential, industry and transport). The primary energy consumption increases in the Centre Case assuming that a gas system is not developed, from 63 PJ in 2000 to around 119 PJ in 2015.

Lignite remains to be main supplier whereas the use of wood decreases from 18% to 12%. The growing primary energy consumption is very marked for lignite and oil in the power and residential sectors. The residential sector consumes 56% of all primary energy in Kosovo as the other sectors mainly rely on the electricity produced there. Of the 66 PJ of primary energy used for heat and power production, only 19 PJ materializes as electricity and heat (and losses) representing an average conversion efficiency of 29%. The main shift for the residential sector is mainly increased consumption of oil, which at present is very low.

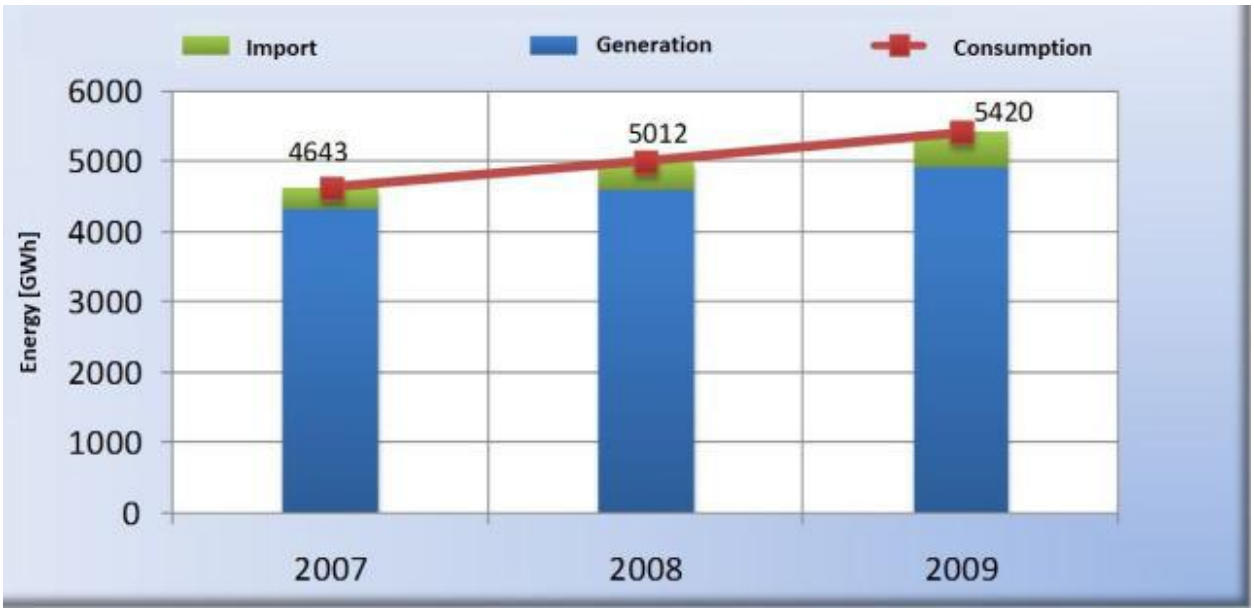


Figure 4-2: Electricity generation and consumption 2007-2009 [6, 27]

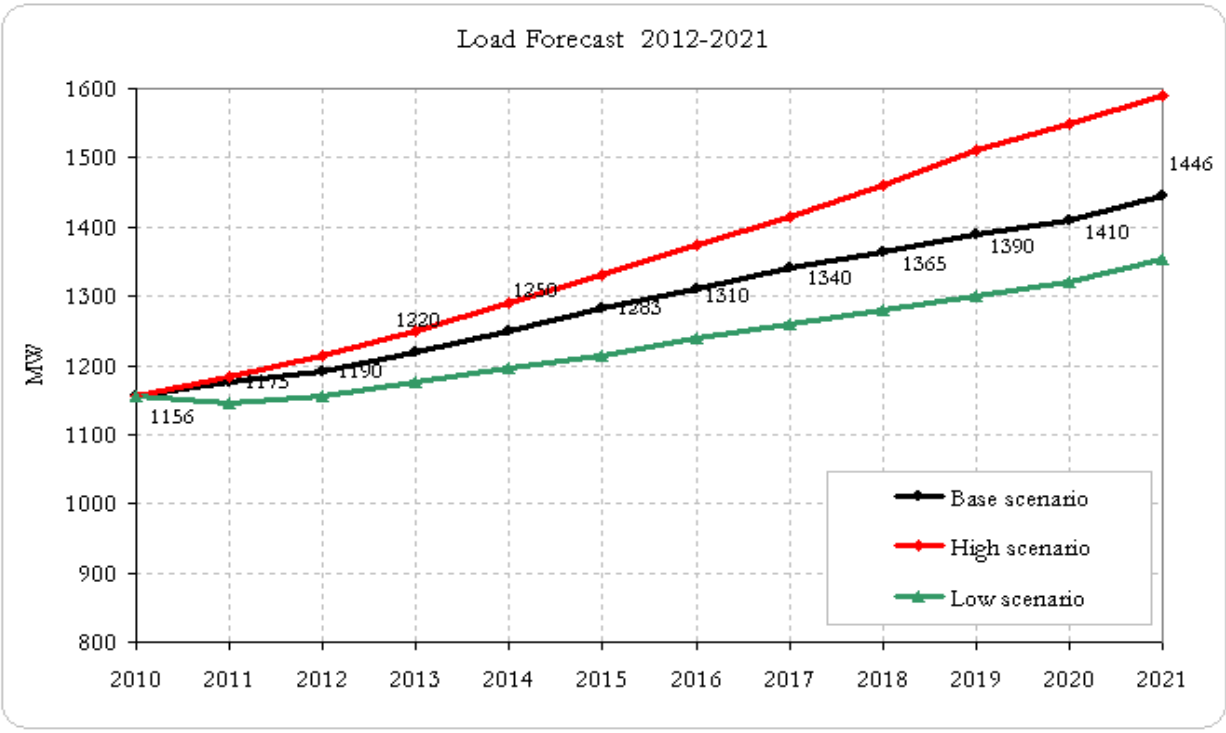
4.3.3. Energy Demand Forecast in Kosovo

Total energy demand is forecast to continue to rise significantly across all sectors except agriculture in the current strategic planning period Energy consumption in 2007-08 shows that Kosovo's energy mix, in terms of the relative shares of different primary energy sources, would remain more or less constant. Lignite's share of the total was expected to increase slightly from 55 to 56 %, and the share of oil to decrease by 1 %%, from 30 to 29 %%.

Total energy demand in 2007 was in amount to 2.201 Ktoe of which 789.13 Ktoe (35.84 %% of the total) was expected to be imported 37. Petroleum products were more than 80 % of total imports, with the remainder being firewood (8.02 %), electricity (9.4 %) and a small amount of lignite (0.42 %). In contrast, only a small amount of energy exports were forecast—19.46 Ktoe of lignite and 27.42 Ktoe of electricity. If the energy consumption is analyzed in all sectors, it might be seen that until 2008 the major consumer of energy in Kosovo was the household sector, followed by industry and transport sector. In the period, 2008 - 2018 industry is expected to increase the % of total energy consumption in Kosovo to over 30%, while the household consumption shall decrease below 30% by 2018. In addition, consumption overview shows that total energy consumption by 2018 is expected to grow from 1,142 Ktoe that is expected to be in 2009 to 1,657Ktoe, or from 1,012 Ktoe in 2003 to 1,657 Ktoe in 2018. The main reason for this growth is the estimated increase of consumption in sector of industry [47].

The implications that will have the measures for the rehabilitation of the electro energetic system will have their impacts in the decrease in the consumption of electric energy, in particular with regards to the savings of the energy in general. Also, policies and measures to encourage energy efficiency will have an effect in

the decrease in energy consumption. Even in the services sector the same effects are in the place. The only sector that will have an increase in energy needs will be the industrial sector. In developing countries, energy consumption in industry represents approximately 45% of total energy consumption of the country, while in developed countries it is as high as 50% of the total energy consumption. Despite the estimates for industrial growth, which subsequently will increase the energy consumption in the sector, proportion of industry in overall consumption of energy in Kosovo by 2018 shall be far from energy consumption in developed countries.



Graph 4-1: Low, basic (average) and high growth scenarios for peak loads (maximum load) [47, 12]

This shows that even in 2018 Kosovo shall be classified as a "developing country". To change this status Kosovo has to develop an own energy sector, to attract more investments and this must be based on domestic energy resources (lignite resource for power generation).

Year	2008	2009	2010	2011	2012	2013	2014	2015
GDP growth(%)	3.192	3,353	3.558	3.813	4.127	4.512	4.982	5.556

Table 4-2: GDP growth in short term according to energy strategy of Kosovo [2, 5].

4.3.4. Energy Supply and Energy Demand Forecast in Kosovo

More than 97 % of Kosovo's domestically produced electricity comes from two large lignite-fired thermal power plants, Kosovo A and Kosovo B. Kosovo B has two generating units and Kosovo A comprises five smaller units. Kosovo A's five units were built over a period of 13 years, from 1962 and 1975. Their outdated and inefficient combustion systems are responsible for emissions at levels that are too high to meet EU standards. At the end of 2007, three of the five units were out of operation due to technical problems and fulfilment of lifespan. Kosovo B, operational since 1983–84, has two units with a combined installed capacity of 678 MW. The high level of capital investment and increased human resource capacity needed to implement these projects place serious limitations on the rate of progress. Kosovo's total electricity production in 2006 was just under 4 TWh with the Kosovo B thermal power plant accounting for nearly three-quarters (74.36 %) of that amount. Kosovo A's three operational units provided around 0.9 TWh (22.5 %), with the remainder (less than 3 %) coming from hydropower plants. In addition, over 500 GWh of electricity was imported, representing almost 12 % of total supply. Domestic energy production fell far short of demand in 2006 and 2007 so those figures are expected to be similar for the future. The total demand for electricity (net demand plus transmission loss) in 2008 was 5,118TWh, with total electricity production by only 4.16 TWh, according to the data provided by Ministry of Energy and Mines {MEM). In general, there is undoubtedly a serious inability to meet net aggregate demand. However, when supply is almost wholly dependent on large-scale thermal power production, the problems become even more complex. The forecast prepared for MGS demonstrates a more constant growth with a slight saturation, meanwhile the HGS is characterized by a considerable growth of demand occurring towards the end of the forecast period.

Thermal power plants are more suited to meeting base load demand—that is, the minimum constant demand for electricity—than meeting peak period demand. Thermal power plants, including those in Kosovo, are generally kept running (although not at full capacity) even during periods when there is no immediate demand. In this respect, Kosovo A's five relatively small units have some advantage in that it is relatively less inefficient to shut down and start up smaller rather than larger units according to demand fluctuations.

However, peak loads are actually best met using mechanical methods of electricity generation, such as hydropower, which are easier and less costly to put on-line. In turn, such flexibility increases the efficiency of an electricity supply system. Domestic hydropower in Kosovo is, however, too small to play this role in the supply. Broadly, demand is lowest over a 24-hour period in the early hours of the morning and there are two main peaks in demand: the first is in the morning, when most people are getting up and businesses start their daily operation, and again in the evening as people return from work. The profiles show a summer minimum base load of just over 200 MW, with maximum peak demand reaching over 850 MW in early evening in the winter.

	Updated MGS-GWh	Updatet HGS-GWh	Actual demand-GWh
2010	4,562	4,562	4,259
2011	4,660	4,725	4,271
2012	4,771	4,908	
2013	4,874	5,090	
2014	4,994	5,299	
2015	5,136	5,539	
2016	5,235	5,764	
2017	5,340	6,009	
2018	5,452	6,276	
2019	5,571	6,568	
2020	5,696	6,845	
2021	5,790	7,119	
2022	5,890	7,417	
2023	5,994	7,741	
2024	6,104	8,094	
2025	6,219	8,477	

Table 4-3: Energy forecast for medium term development

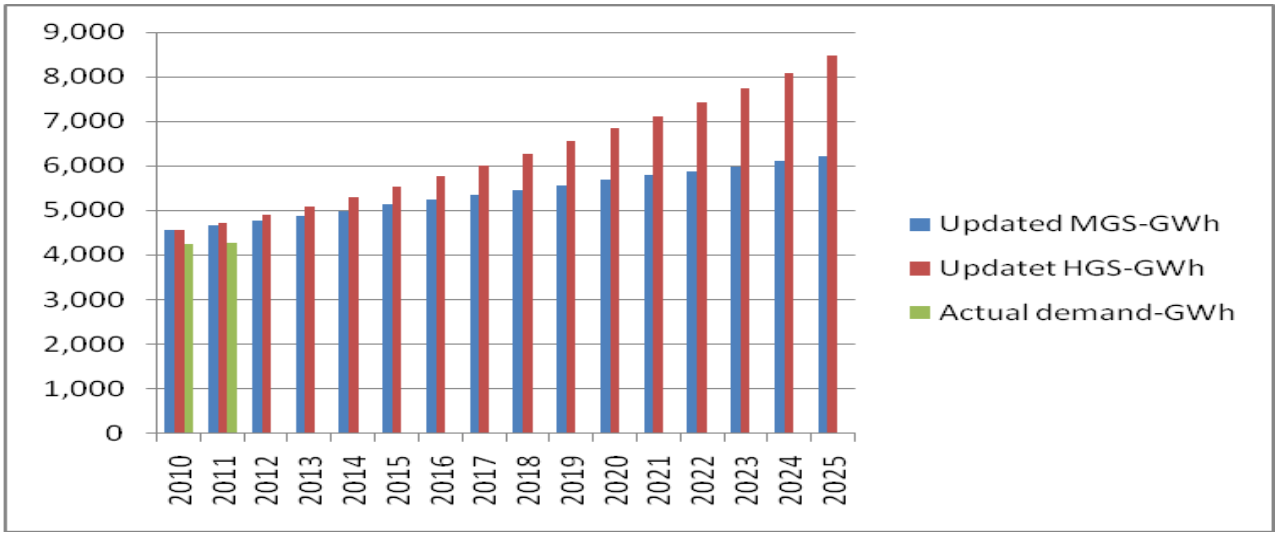


Figure 4-3: Forecast of energy supply in Kosovo (medium term) [2]

Chapter V

5. PRODUCTION OF FOSSIL ENERGY RAW MATERIALS WORLDWIDE AND IN KOSOVO

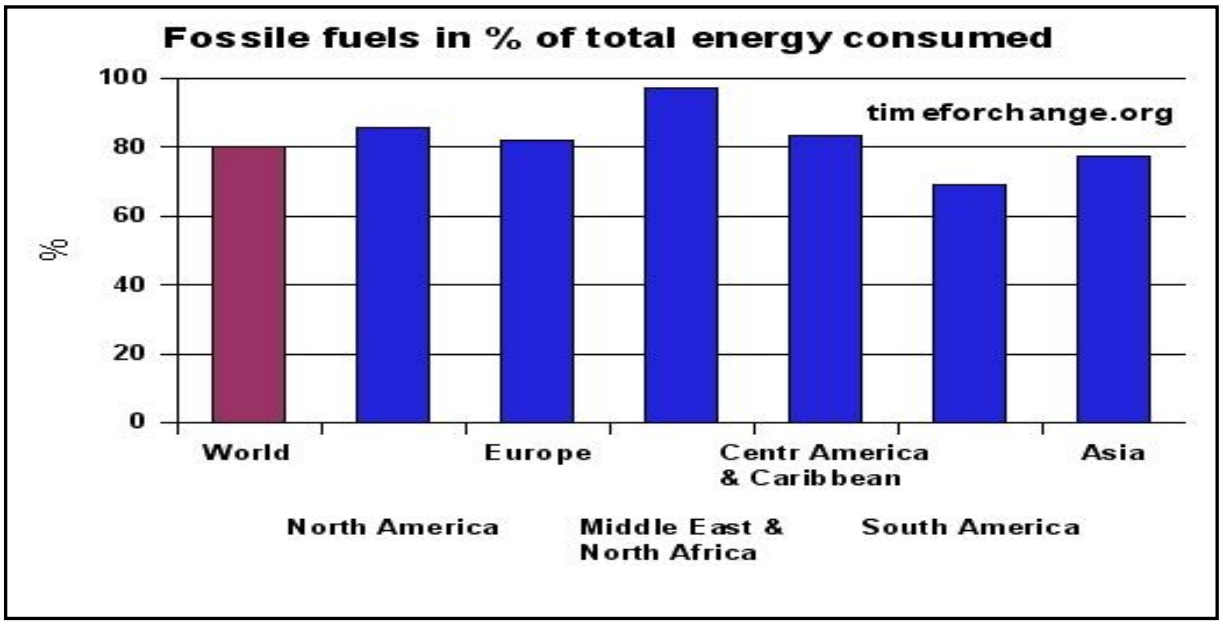
In this chapter the global production of the energy raw materials is described in global view and also particularly for Kosovo case. Lignite is of outstanding importance to electricity generation in Kosovo. Lignite supply can rise in correlation with increasing electricity consumption. Lignite can be supplied with the highest degree of security and with predictable price levels. By this, Kosovo can take advantage of its large reserves and of its location in centre of South East Europe, where lack of electricity is to be expected in the mid to long term period. Lignite is of major significance for Kosovo as it provides direct and indirect employment for thousands of people in the lignite mining, electricity generation industry and other sectors as well.

5.1. Worldwide Production of Lignite and Other Types of Fossil Fuels

When discussing the future availability of fossil energy resources worldwide, globally we agree that there is an abundance of lignite which allows for increasing lignite consumption far into the future. This is either regarded as being a good thing as lignite can be a possible substitute for the declining crude oil and natural gas supplies or it is seen as a horror scenario leading to catastrophic consequences for the world's climate. But the discussion rarely focuses on the premise: how much lignite is there really? Analysis shows us an outlook on the possible lignite production in the coming decades. Lignite-Brown lignite is an energy raw material of global meaning and, hence, is diminished in a big number of lands. As it is mentioned already some 14 milliard of tones are located in Kosovo. The world supply of lignite went up by 0.9 % in 2006 and reached 913.8 Mt, following an increase of 1.3 % in 2005. Unlike the situation for hard lignite, many European nations feature amongst the top producing countries. Europe is responsible for around 50% of world production, where it represents an energy resource of key importance. EU production of lignite has been fairly stable in the period from 2004 to 2008. Over 90% of lignite is used in power stations with the remainder being largely used for domestic heating, mainly in the form of briquettes. The increase in the import prices of hard lignite is strengthening the competitive position of lignite production especially in the lignite sector. This results in a more stable contribution to the security of energy supply.

However, the heating value of lignite is much lower than that of bituminous and even lower than that of sub bituminous lignite. Lignite is predominantly used for domestic heating and power production purposes and is not transported over large distances because of its low energy content. Besides, Germany is with a participation of more than 20% the world-biggest producer, followed by the USA, Russia, Greece and

Australia. Other important brown lignite producers are a Poland, Turkey, Czech Republic as well as China. The performed land produces about 75% of the world production [42]. Kosovo with over 12 Milliard tonne lignite reserves is in third place in Europe.



Graph 5-1: Fossil fuels worldwide [46]

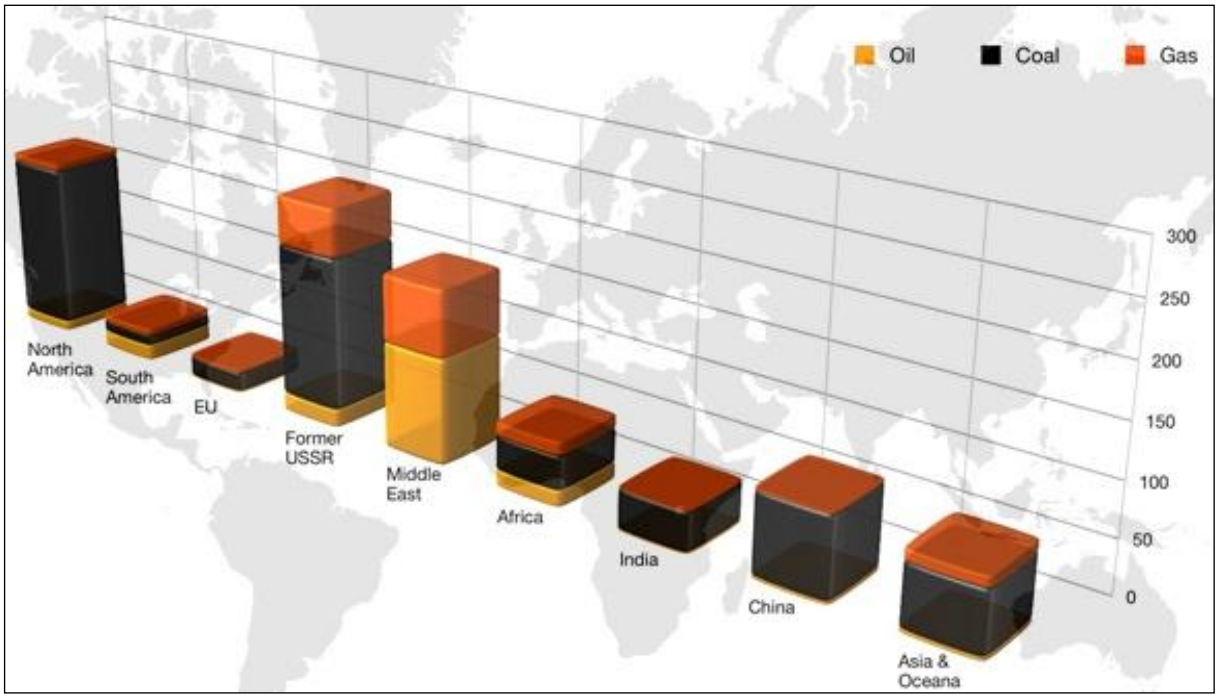


Figure 5-1: Proven coal and other fuel reserves worldwide 2009 [42]

5.2. Lignite Reserves in Kosovo

Most recent figures indicate that explored lignite resources are estimated to be mineable manly in the Kosovo lignite basin and Dukagjini lignite basin and also smaller lignite fields like: Drenica, Malishevë, Babush i Muhaxherëve lignite basin and one potential lignite basin in southern part of Kosovo (Kaqanik area). The original overburden shows a thickness of 60 m- 120 m. As being one of the major deposits in the country the Kosovo Lignite Basin covers about 85 km from North to South with an average East – West extension of 10 km. Hence the deposit comprises some 850 km². Morphologically the Kosovo Lignite Basin forms an extended valley where the differences in elevation do not exceed 80 m.

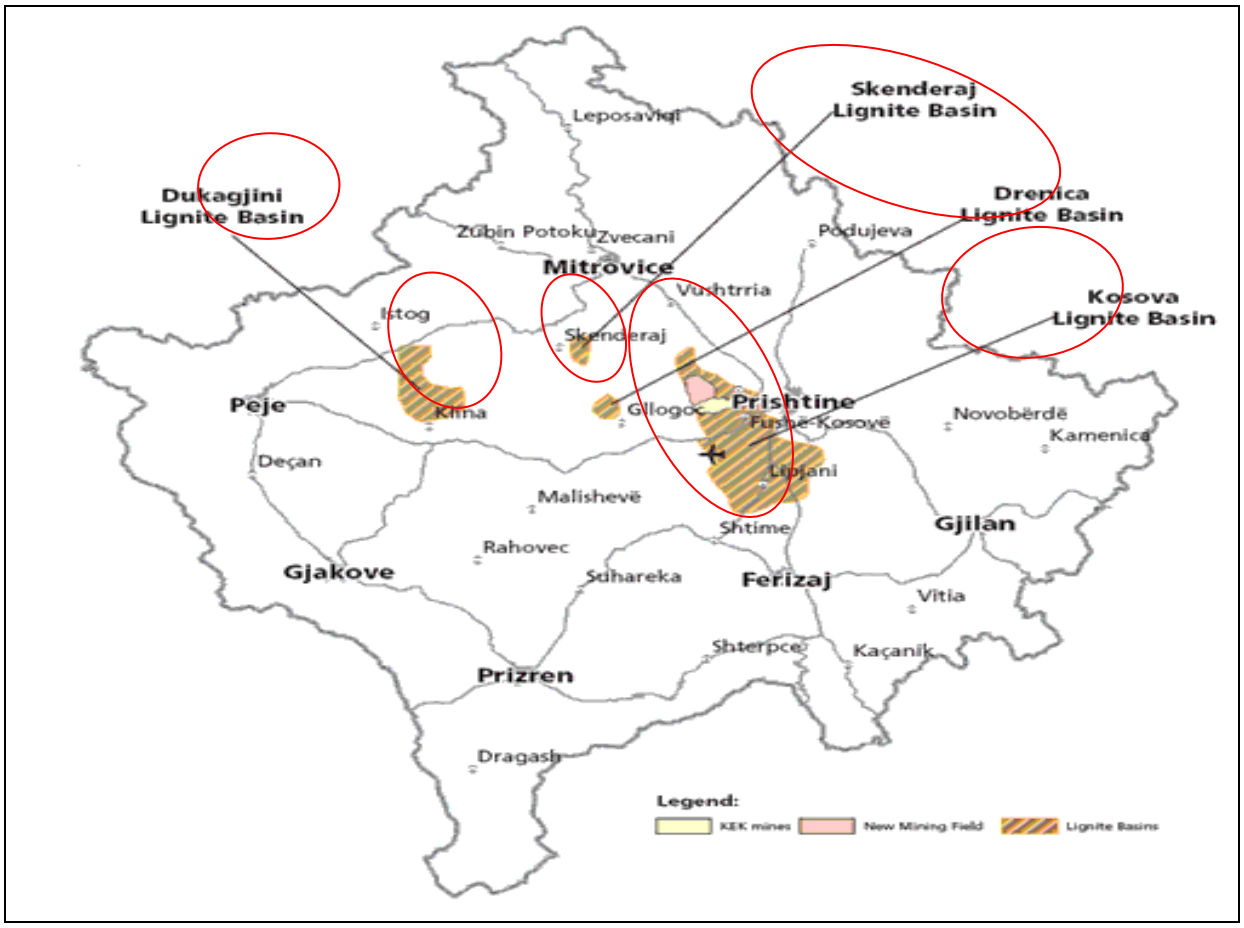
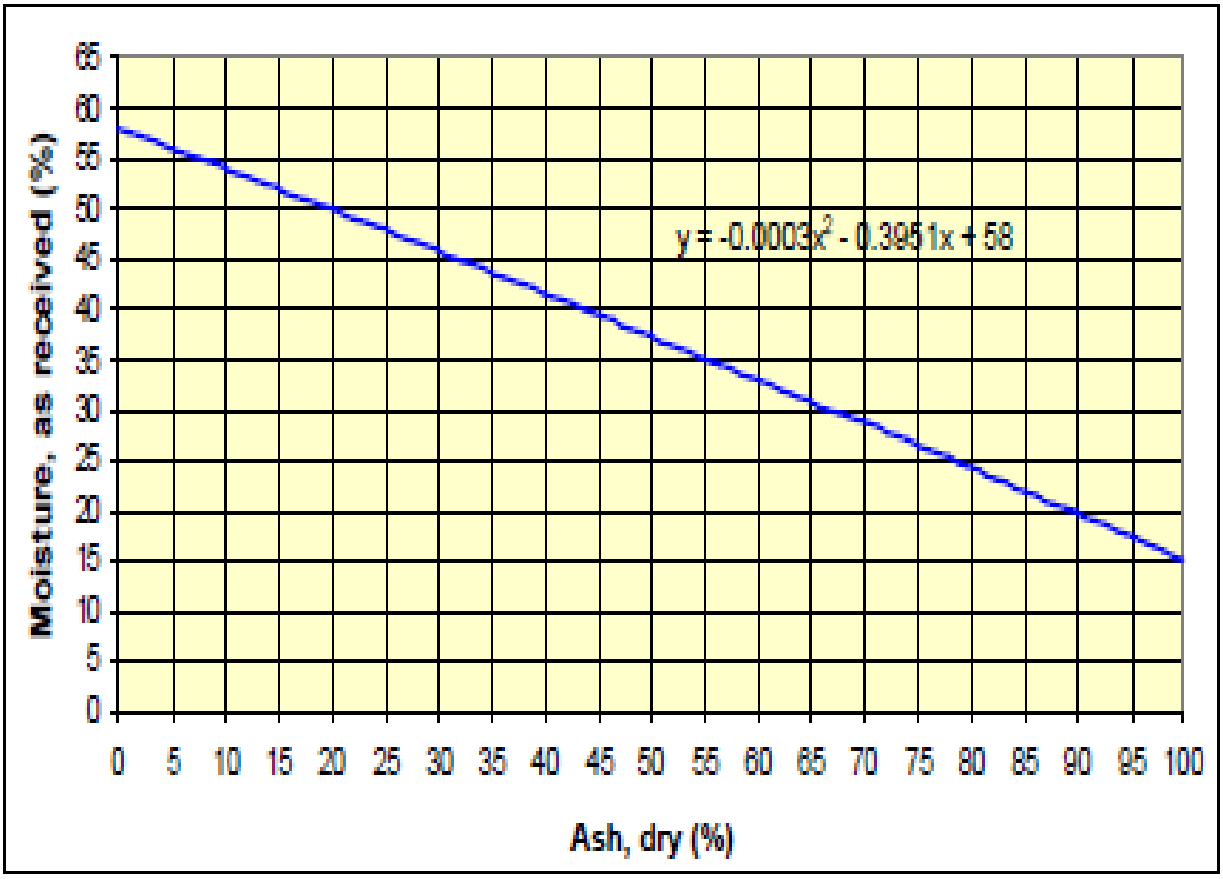


Figure 5-2: Lignite Deposits in Kosovo [44, 23]

5.2.1. Lignite Quality Parameters

For any future mine planning the lignite quality data must be based on standard analysis which are very important for further operations in the sector. Therefore all analysis data on 45% moisture content were recalculated to the individual in situ moisture contents.



Graph 5-2. Relation moisture/ash [34]

There is a general relation between ash contents of lignite and the corresponding moisture contents. As this relation is not exactly known for the Kosovo lignite, the necessary analyses are undertaken in labours from Technical University of Freiberg. The relation between moisture content (as received) and ash (dry) and the relation between heating values on 45% average moisture contents and heating values are estimated based on the variable in situ moisture contents. High heating values (at 45% moisture content) are reduced by about 1500 kJ/kg due to the fact that these lignite's have in fact up to 55% moisture content while low heating values (at 45% moisture content) are increased by about 1500 kJ/kg as these lignite's have in fact less moisture content of around 35% only.

The average values of lignite quality parameters of the different mine areas are shown in table below. Average seam moisture contents vary between 42% and 49%. Moisture contents at Bardh-Mirash are likely to be around 47, 5%, while at Mirash East (Sitnica area) they show a magnitude of 44% due to higher ash contents. Ash contents vary between 7% and 35% within the lignite seam. The average values of ash content are around 14% to 17%.

Parameters/Country	Kosovo	Australia	Bulgaria	Germany	Poland	Turkey
	Siboc	Loy ang	Maritza	Rhenish	Belchatov	Elbistan
Calor.Value (kJ/Kg)	8100	8000	6700	8900	7800	4400
Ash (%)	14	1.5	12	5	11	18
Sulphur (%)	1	0.4	1.9	0.3	0.6	1.7

Table 5-1: Kosovo lignite quality parameters compared to the fuels from other countries [13]

Heating values are in the order of 7800 kJ/kg on average in the Bardh-Mirash area, while in the south-west part of the Siboc area they show values around 8100 kJ/kg. Individual samples from Bardh-Mirash boreholes show minimum/maximum heating values of 3500 kJ/kg and 11800 kJ/kg, respectively. Kosovo leads third place after Germany and Poland in Europe and this type of lignite is very competitive with European lignite reserves and below are provided comparison data for that (see graph below):

Country	Reserves [1000 Mt]
Germany	42.8
Poland	14
Kosovo	14
Hungary	7.8
Turkey	5.9
Greece	4.2
Czech Republic	3.5
FR Yug	3.06
Romania	3
Bulgaria	2.5

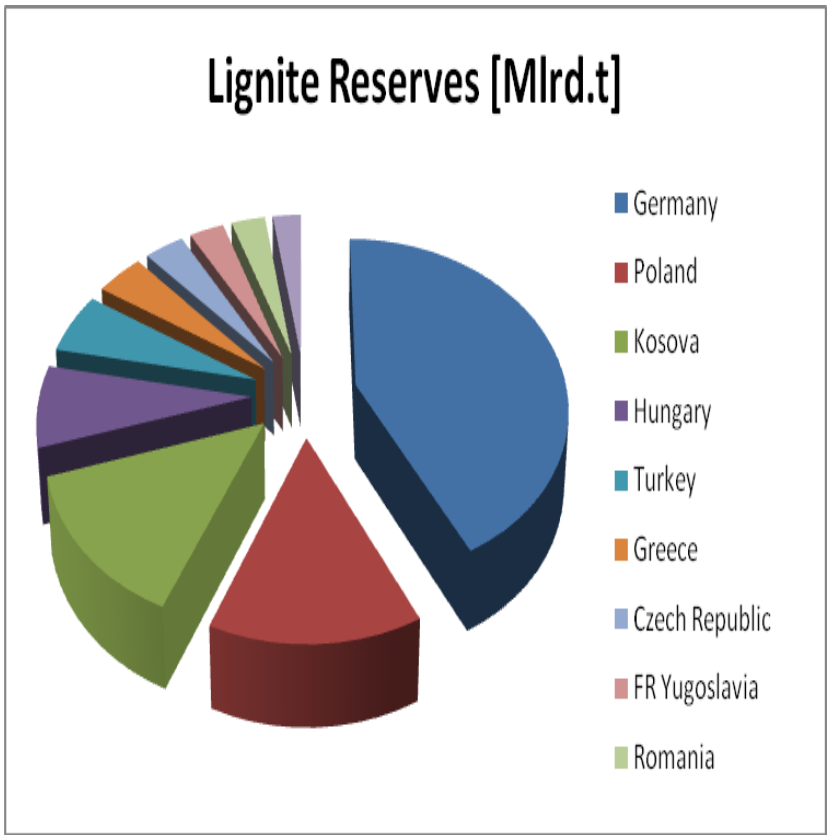


Table 5-2: Comparison of lignite reserves

Graf 5-3: Kosovo reserves compared to other countries

5.3. Production of Lignite and other Energy Resources in Kosovo

Lignite is a fossil fuel that is combustible, sedimentary, organic rock, which is composed mainly of carbon, hydrogen and oxygen. It is formed from vegetation, which has been consolidated between other rock strata and altered by the combined effects of pressure and heat over millions of years to form lignite seams. The degree of change undergone by a lignite as it matures from peat to anthracite – known as ligniteification – has an important bearing on its physical and chemical properties and is referred to as the 'rank' of the lignite Low rank lignite's, such as lignite and sub-bituminous lignite's are typically softer, friable materials with a dull, earthy appearance. They are characterized by high moisture levels and low carbon content, and therefore low energy content. Higher rank lignite's are generally harder and stronger and often have a black vitreous lustre. They contain more carbon, have lower moisture content, and produce more energy. Anthracite is at the top of the rank scale and has a correspondingly higher carbon and energy content and a lower level of moisture. Currently only Kosovo basin is being exploited in two open cast mines Bardh and Mirash. Operations are performed by public owned mining and power generation company Korporata Energjetike e Kosovës (KEK). Mining operations are ongoing on two open cast mines: Bardh and Mirash mine. There actually are ongoing four working fronts in the actual open pit mines:

1. Bardh
2. Mirash-East
3. Mirash-West
4. Mirash-Brand

Operations at Mirash-East have been stopped due to depletion of accessible reserves. Further operations in this area require relocation of Sitnica River to reach additional 28 Mt of distorted low quality lignite. Open cast mine of Bardh has recently suffered a land slide that damaged overburden and all lignite benches. It will require additional time and investments to re-establish all benches and normal production. In Mirash-West a backlog of overburden removal and poor operational condition of main mining equipment gives unstable lignite production. Practically major lignite production comes from Mirash-Brand were reserves will be depleted within next year's [7, 2].

Lignite Production & Consumption (2008)	Mt
Total Lignite production	7. 096
Total Lignite consumption	6. 796

Table 5-3: Lignite Production and Consumption 2009 [41]

Last estimation indicates that mines in operation will be completely depleted by 2012/13, with a significant decrease of output starting from 2011. Kosovo has a range of renewable energy resources including hydropower, and biomass, as well as geothermal, wind, and solar energy. Wood is also an important resource used for heating in individual houses. The total wood area in Kosovo is more than 4,000 km2, with a wood stock of 30 million m3. The yearly growth of the wood stock is around 1.0 million m3, compared with an estimated yearly consumption of around 1.0 million m3 of firewood alone. Except lignite, hydropower resources are only on a very small scale available. The planned HPP Zhur with about 292 MW installed power and total annual generation of app. 400 GWh, representing almost 60% of potential hydro energy production is technically feasible but is very difficult to find financial investments for such project with lower level of utilization factor. Geothermal energy is available in the different parts of Kosovo in Malisheva, Kllokot, Peja, however in small scale and those resources have not been determined and well explored. Wind resources are assumed to be scarce due to the location sheltered by mountain chains in most directions. Solar heating is in some contexts regarded as a potential low-temperature heat source. Based on meteorological data for Kosovo and the efficiency of modern solar collectors it is reasonable to assume a peak production capacity in the months of July and August of approximately 300 W/m^2 and a total yearly production of approximately 360 kWh/m^2/year. According to all this it appears that the only one reliable source for energy production in Kosovo is lignite.

The lignite of the Kosovo basin belongs to the upper Miocene and has an age of about 9 million years. The seam has been faulted to some extent with a main fault in NNW/SSE direction. There are a series of minor faults parallel and traverse to the main fault. The seam is generally rather flat. Dip of strata can be up to 10° locally. Borehole density is 250 m x 250 m in the active mines, locally even more. In Siboc area the borehole density is also 250 m x 250 m with some locations showing only a 500 m x 500 m grid.

The lignite seam thickness varies between 56 m and 70 m. The original overburden coverage shows a thickness of 60 m – 120 m. In the east (Sitnica area) only about 10 m of overburden are present. The overburden itself mainly consists of silt and clay strata with some sandy horizons which act as aquifers. Water seepage from these aquifers, however, is of minor impact and does not affect mining operations or the regional environment or any other water use. The central area, the “Kosovo Lignite Basin”, is spreading out at a surface of approximately 300km². Simplified, the succession can be subdivided as follows:

- Bottom Series (Grey and yellow clay)
- Lignite Series (Lignite Formation)
- Top Series (Green clay)

The area of the Siboc field shows numerous faults and is bordered by two N-S orientated main faults. At the western border area, the lignite seam is cropping out dipping with 45° into eastern direction of the Siboc field.

The sections are two-times exaggerated in the vertical direction. The seismic traces are displayed as variable amplitudes with normal polarity. Hereby, red amplitudes indicate negative reflection coefficients resulting from an interface with higher impedance (the product of density time's velocity) in the hanging wall than in the footwall layer. Blue amplitudes are from negative reflection coefficients. The top of the lignite seam is expressed by a red reflector mainly created due to the drop in density between the overburden clay and lignite [17].

The definition at base seam is generally poorer due to the mixed lignite/clay bedding at the base of the seam. Clear signal is recorded at Top and Base lignite seam where no mining activities or advanced slide systems are known, i.e. north of the pillar near Hade. Here, only weak internal reflection bands are developed. The underlying green clay shows a dense succession of parallel bedding, likely expressing intercalations of coarser grained layers. Directly to the south of Hade intensive faulting is visible on the seismic data. The fault geometries indicate mainly reverse faulting within a transgression shear zone [18].

5-3-1. Environmental Impacts of Mining Operations

The review of the impact of the mining operation on the environment has been carried out considering past damages and future effects of the mining operation. Measures to minimize the future effects of the mining operation like dust and noise emissions, water pollution and resettlements have been planned and analyzed. Taking into account large impact of the past damages, two main areas of concern have been identified; the recultivation of the old outside dumps and the extinguishing of smouldering mine fires. The recultivation of the outside dumps can be carried out at reasonable efforts and costs. However, special intention must be paid to the mine fires, which cause environmental problems (air pollution), safety problems in the mines and an economic damage on the deposit. Lignite reserves in currently operating mining fields will cover lignite demand of existing power plants for the next 8-10 years with a condition that Sitnica River will be relocated in time. New mining fields (Siboc field, Field D and South field) should be developed to meet lignite demand of existing and new power plants for next 40-50 years in middle term option. Dukagjini and Drenica basin are future possible solutions beyond that for the next period over 80-100 years.

5.4. Development of Strategic Objectives

Kosovo has to face with the challenges of economical development and this is directly linked to secure energy supply as supporter of this development and foreign direct investments. According to this the primary duty is to establish clear strategic objectives for mining and energy sectors. These objectives should include:

- Encouraging the exploration and use of domestic deposits of lignite in environmentally responsible way as key point for future strategic decisions in Kosovo

- Development of long term plans for lignite mining in various locations in Kosovo including assuring proper spatial planning permissions and protection of the areas where lignite deposits are located
- In mean time the achievement of climate of trust, open information sharing and fair issue resolution between the lignite mining industry and local communities.
- Preparation a clear and stable legal security and infrastructure for possible investitures and take advantage, because Kosovo is central located in South East Europe, where lack of electricity is to be expected in the mid to long-term period and this can attract export oriented power producers to invest here.

This will help economical development of the country and will maximize employment opportunity, with reference to skilled occupations for which there is potential for employment over the long term and in which skills are transferable to other industry sectors (like ore mining or generation for instance). Those steps must encourage land reclamation and restoration in present and former lignite mining areas but in mean time mining and energy industry has to develop research and development initiative in lignite mining and clean lignite technologies, to create a high level of public understanding about the economic impact of lignite exploitation for electricity generation.

CHAPTER VI

6.0. PRIMARY LIGNITE FIELDS FOR SHORT TERM DEVELOPMENTS

For the development of the mining sector in short term views the actual mines in Bardh and Mirash are very important. Parallel to this, it's rather important to start developing a new mine in the southeast part in Siboc field where the potential in constrains is very low and this shows a great possibility starting operation there without hug investments while that part of Siboc field is directly connected to the almost exhausted mines. However there are other options to ensure the fuel supply for short term energy production and secure the consumers that there will be no gap between actual production and rising demand in medium and long term energy production. Here below are presented fields that are from great importance for short term developments in energy sector in Kosovo.

6.1. Lignite Reserves in Short Term View –Actual ongoing mining activities

Actually the Bardh and Mirash mines are the only supplier of lignite for the existing power plants. To evaluate the contents of the remaining reserves of the actual and future mine areas mass calculations were carried out using the mine planning software DATAMINE. An average density of 1.14 t/m^3 for lignite has been taken for reserve calculations. For the areas of Brand and Mirash East existing plans provided by Kosovo Energy Corporation (KEK) have been used to define the mine boundaries. The boundary of the Siboc mine is given by the limit of the lignite deposit on the western side, the existing main exit of the Bardh mine on the eastern side and the southern limit is defined by the northern slope of the Bardh mine. Below are analyzed potential fields for short term development.

6.1.1. Pillar between Bardh and Mirash West

The first step was to develop a final slope system for the northern as well as the southern slope. For this purpose the uppermost overburden benches of the existing mines Mirash west and Bardh were extrapolated to meet each other. From there, a slope system with a maximum general inclination of 1:2.5 (V: H) was projected down to the top of the lignite seam. The general inclination in the lignite was designed to be 1:1 (V: H).

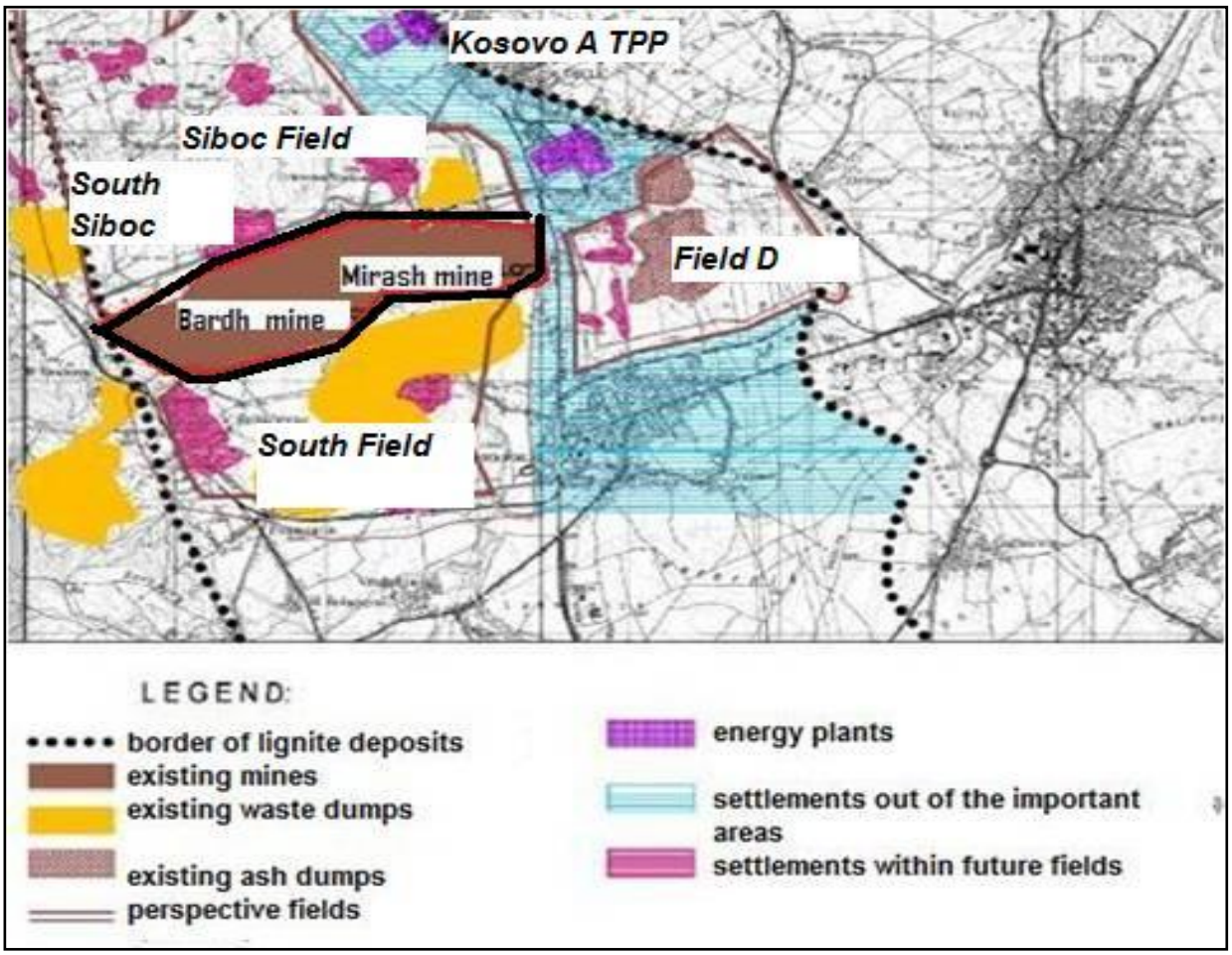


Figure 6-1. Active Open Pit Mines Bardh and Mirash [31]

These inclinations take into account the geotechnical parameters of the overburden material and lignite, respectively. The northern slope includes extra space on the terms for installation of the lignite transport conveyors. The overburden was divided into three excavation benches and the lignite was divided into four benches Bardh and Mirash mines. All data obtained from different sources (KEK, MEM, INKOS) are calculated and according to that the mass calculation results are as follows:

Bench	Overburden (m^3)	Lignite (Mt)	Total volume (m^3)	Ash (%)	LHV [kJ/kg]:	Moisture (%)	Sulphur (%)	Stripping Ratio (m^3/t)
1	78.685.112	8.071	149.855.7	14,28	7.806	47,60	0,9	0,97/1

Table 6-1: Mass calculation for the pillar between Bardh and Mirash open pit

6.1.2. Mirash Brand Mine

The Mirash mine is separated in three different areas, Mirash West, Mirash East and Mirash Brand. In Mirash West there is only limited lignite production at present due to the fact that the removal of overburden has been seriously neglected during last year's. However, the lignite production continued until the width of the benches within the lignite zone of the pit had been reduced to a size which did not allow the use of continuous mining equipment any longer. As a result, the system of lignite benches has to be redeveloped.

At the same time the backlog of overburden removal must be reduced to ensure a safe and continuous lignite production in the future. In Mirash East a further development of the mine calls for a relocation of the river Sitnica. This could be one of obstacles and constrain potentials although the risk of this very low. The overburden removal has therefore been stopped. The mining of the exposed lignite reserves within this area is jeopardized by the geotechnical instability of the excavation front. At the moment Mirash Brand provides for the lion's share of the lignite production coming from Mirash mine. The momentary stripping ratio is relatively low compared to the other mining areas. However, there are obstacles which will have to be removed for the development of the mine. These obstacles are the completion of overhead line relocation, the removal of buildings and scrap in front of the excavation

The remaining reserves in the Brand area will be mined out in the near future. There are hug masses of overburden to be removed and one overburden excavator and one spreader will uncover the lignite; whereas the lignite will be mined using modern machinery in order to increase the production. This is necessary to cope with the overburden backlog still existing at Bardh and Mirash West. Because this is operative field actually there are no constrain potentials except geotechnical instability of the area and lignite fire in open pit mine. These problems have to be solved by improvement of technical work done in the mine. The lignite can be sent to either TPP Kosovo 'A' or Kosovo 'B' and the mass calculation results are as follows:

Bench	Waste (m^3)	Lignite (Mt)	Total volume (m^3)	Ash (%)	LHV (kj/kg)	Moisture (%)	Sulphur (%)	Stripping Ratio (m^3/t]:
1	1.295,108	8.349	8,619,279	16,53	7,991	46,24	0,97	0,16/1

Table 6-2: Mass calculation for the Mirash Brand area

6.1.3. Bardh Open Pit Mine

The backlog of overburden removal amounts to more than 7 Million cubic meter in total, with an upward trend. Production is still possible, but the overburden removal especially at the uppermost overburden benches is not sufficient to catch up with the backlog. As a result, the width of the benches is decreasing

which will affect the utilization of the mining equipment in the future. In return, this will further affect the situation regarding the backlog of overburden removal. The operation of the lignite excavations is hampered considerably by the narrow benches. Some of the lignite benches are completely missing. The development of the lignite excavation and utilization is clearly reflecting this situation. It will be inevitable that the lignite release capacity of Bardh mine will further decrease unless appropriate remedial actions are applied.

Bench	Waste (m^3)	Lignite (Mt)	Total volume (m^3)	Ash (%)	LHV (kj/kg)	Moisture (%)	Sulphur (%)	Stripping Ratio (m^3/t)
1	9,113,245	12,354.67	22,678,132	10,96	8258	48,34	0,82	0,63/1
2	7,860,054	9.768	18,453,342	11,09	8310	46,98	0,89	1,98/1

Table 6-3: Mass calculation for the Bardh mine

There are just few constrain potentials in view of resettlements or other directly impact factors. The environmental situation of the mine sites is characterized by fires at the outcrop of the seams within the slope system of the pits. Spontaneous ignition of the lignite is the reason for the lignite fires at both mines. Unless these fires are extinguished the following problems are caused by them like: destabilization of slopes, geotechnical activities in those areas and old underground mines who serve as place for oxygen

During the summer the fires still a risk for main mine equipment in several cases. The thick fog –smog observed frequently during the winter months might be related more to the air pollution than to the lignite fires. Anyway these causes health risks for workers and the people living close to the mines, related to the air pollution.

6.1.4. Constrains, Evaluation and Lignite Production Scenarios for the Short Term

Because Mirash and Bardh mines in near future will be exhausted there is very important to define the possible fields that can support fuel supply to the Kosovo power plants in short term view, until 2018. Actual mines are operative fields and actually there are no constrain potentials except geotechnical instability of the area and lignite fire in open pit mine. These problems have to be solved by improvement of technical work done in the mine. There are no potential constrains relevant so there the mining operations can go ahead without any obstacle except technical difficulties. Short term developments in energy and mining sector in Kosovo are undergoing big changes and challenges so there is necessary to have prepared alternative scenarios which are reliable for energy production in the country. Thereof was necessary to compare data for all fields around existing mines and below are the comparison analysis that have been

made in order to rank the best fields for the short term fuel supply: However during the analysis was taken into consideration that in short term scenario developments are somehow predicted through field licences and governmental decisions.

6.1.4.1. Mirash East

When the Brand area will be mined out the lignite production can be continued in the East Mirash area which is located near to the river Sitnica. The final slope system of the future Mirash east mine will end at a distance of approximately 150 m west of the railroad Mitrovica -Shkup. For this purpose the river has to be re-located to a position along the western side of the railroad tracks. Analysis from obtained data for this field shows those results for the mass calculation as follows:

Bench	Waste (m^3)	Lignite (Mt)	Total Volume(m^3)	Ash (%)	LHV (kj/kg)	Moisture (%)	Sulphur (%)	Stripping Ratio (m^3/t)
1	9,017,317	25.35	33,902,317	19197	7,928	43,24	0,97	0,32/1

Table 6-4: Mass calculation for the Mirash East area

Because this mine is part of Mirash field the resettlements doesn't represent hug constrains. However there are few houses to be relocated and in this regard this option has advantages. Also small parts of national and regional roads need to be relocated. Below are the main impact factors analysed and according to them the evaluation followed later an.

Mirash East	Data
Total Area [Km2]	3.7
Geological Lignite Resources[Mt]/ Total Area [Km2]	224/3.7=60.5[Mt]/[Km2]
Mineable Resources [Mt]/ Total Area [Km2]	190/3.7=51[Mt]/[Km2]
Stripping Ratio [O/L]	0.9:1
Average Calorific Value	8.300
Corresponding Size of TPP [MW]	1,000 – 1,400

Inhabitants/ Number of affected inhabitants and [%]	1220/130(9.3%)
Regional dispersion of lignite resources from actual mining	No
Water availability	Yes
Economical impact	yes
Extraterritorial jurisdictions of communities	no
Highway(m)	0
Regional and local road (m)	2567
Distance of lignite from PP (m)	900
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	500
Natural protected areas(Ha)	170

Table 6-5: Data for the Mirash East area

In the natural protection areas the constrain potentials of the field shows that even there must be also partially relocation of Sitnica River and some estates from village Dardhishte.

6.1.4.2. South Siboc Field

Instead of a future mine at Mirash East a new mine could be opened up in the area north of Bardh mine. This mine would advance in northern direction. The existing lignite conveyors leading to the power stations could remain in the current position. A part of the old outside dump Shipitulla has to be excavated in order to uncover the lignite reserves. The overburden material can be dumped within the depleted mine areas Bardh and Mirash East. This will provide a filling-up of those areas to the original ground level for reclamation and final return of the land to the surrounding communities or for an exchange of land for future relocation of farms and/or settlements.The area of the South Siboc field is mostly used for agriculture. For a long time it has been known that this lignite field is envisaged for excavation. Therefore, the people living in this area are prepared for mining activities. Previous plans included the mining from South to North

whereby it was intended to develop the field from the existing rim slope system of Bardh/Mirash. Small private coal openings exist which are used for local fuel use.

South Siboc mining field is sparsely populated and the resettlement of the before mentioned villages is the major obstacle for the exploitation. There are no other restrictions for the coal mining. The Siboc field has large coal content and is characterized by favorable deposit condition. The lignite has a high quality and the excavation is not largely affected by extensive recovery of outside dump material.

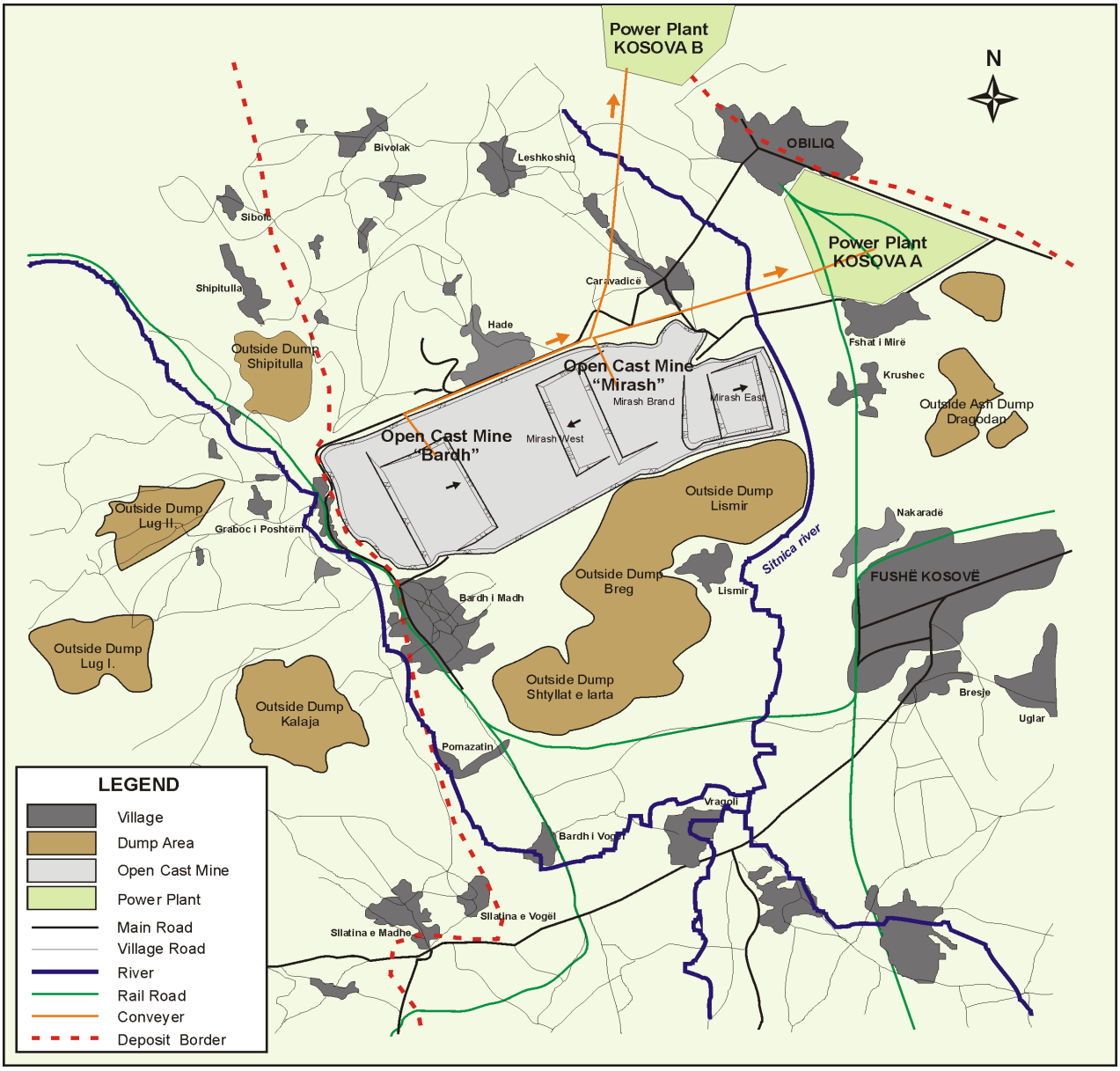


Figure 6-1. Active Open Pit Mines Bardh and Mirash with possible future Active Open Pit Mines for short term fuel production (black lines) [31]

South Siboc Field	Data
Total Area [Km2]	3.7
Geological Lignite Resources[Mt]/ Total Area [Km2]	224/3.7=60.5[Mt]/[Km2]
Mineable Resources [Mt]/ Total Area [Km2]	190/3.7=51[Mt]/[Km2]
Stripping Ratio [O/L]	0.9:1
Average Calorific Value	8.300
Corresponding Size of TPP [MW]	1,200 – 1,400
Inhabitants/ Number of affected inhabitants and [%]	5323/1645/ (32.3%)
Regional dispersion of lignite resources from actual mining	No
Water availability	Yes
Economical impact	yes
Extraterritorial jurisdictions of communities	no
Highway(m)	0
Regional and local road (m)	1550
Distance of lignite from PP (m)	450
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	100
Natural protected areas(Ha)	220

Table 6-6: Data about the South Siboc Field

South Siboc Field	Inhabitants	Number of inhabitants	Affected inhabitants [%]
Hade	2892	980	29.5
Lajthishte	1284	375	34.2
Palaj	1147	290	39.5
Summary	5323	1645	32.3

Table 6-7: Settlements affected by Siboc Lignite Field

Another advantage of this field is the moderate transport distance to the power plant. Developing the Sibovc field from the South has the best potential of all scenarios to fill the Bardh and Mirash pits with overburden masses. Both possible fields are analyzed similar to the example that is given in Chapter VIII, IX and X. According to this the Mirash east will be used firstly and after that the South part of Siboc will overtake the lignite production.

For short term period Field D and South Field are as well analyzed but however because of old ash dumps and short time activities those two fields are excluded from combination while simply solutions Mirash east and South Siboc offer much favorable possibilities. Also the overburden/lignite ration is not favorable compared to the South Siboc and Mirash east.

The Kosovo Power Plants A and B currently consume six to seven Mt per year. This level is not sufficient to satisfy the electricity requirements, particularly as the demand will increase in the coming years. By the beginning of 2012 about nine Mt of lignite will be required per year, achieving the maximum demand in the short term supply by approximately 15.87 Mt per year by 2018.

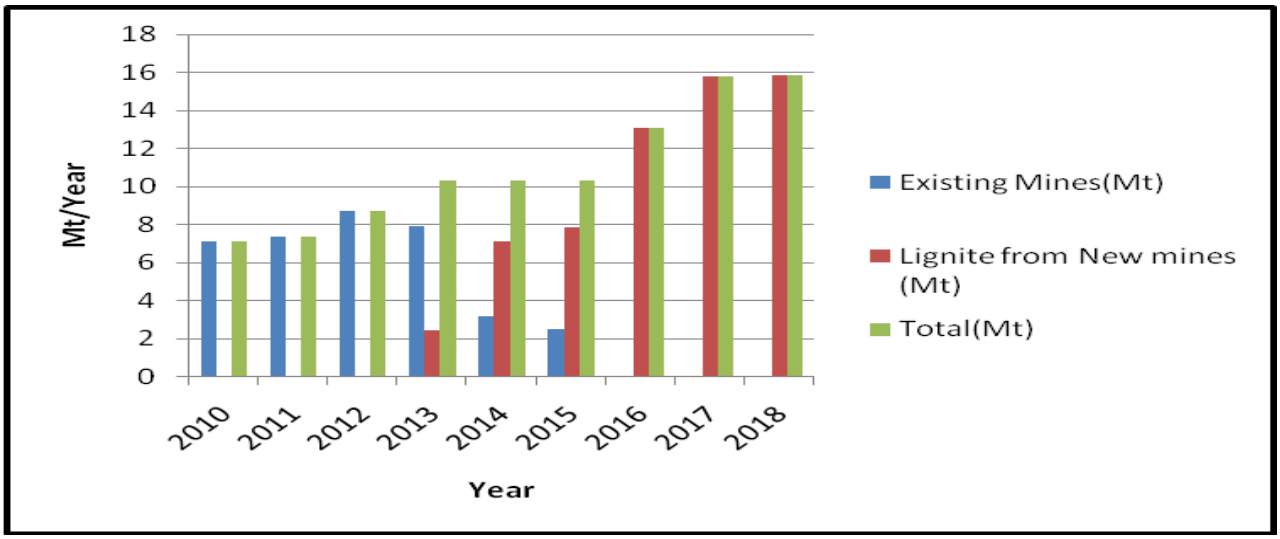
The production will be achieved by operating the mines Mirash and Bardh until a year 2015. Within the planning horizon connection fields are required. In this case connected from Mirash Brand the new Mirash East field will start to produce and support supply by 2013 and finally by 2016 the South Siboc field will overtake the full supply of old and new power plants with total amount of lignite production to some 13.06 Mt per year at 2016, increasing this up to 15.87 by 2018.

Further development of the mining area Mirash East to the eastern direction (Mirash East/ Sitnica) and subsequent development of the Siboc south west field north of Bardh mine is from immediate importance in order to ensure the necessary fuel demand from generation sector in Kosovo.

The assessed output of coal from the existing mines (Bardh/Mirash) and the coal haulage required from the new mine(s) is shown as follows:

Year	Lignite from Mirash/Bardh (Mt)	Lignite from new mines- Mirash East and South Siboc (Mt)	Sum = Demand of Lignite (Mt)
2010	7.1	0	7.1
2011	7.4	0	7.4
2012	8.7	0	8.7
2013	7.9	2.45	10.35
2014	3.2	7.15	10.35
2015	2.5	7.85	10.35
2016	-	13.06	13.06
2017	-	15.77	15.77
2018	-	15.87	15.87

Table 6-8: Lignite demand schedule until 2018



Graph 6-1: *Production Lignite Schedule in Short term view*

The coal demand scenario set out in table above bases on the following principles and assumptions:

• For the time up to 2012 the production level already planned is applied, that means up to 8.7 Mt/a will be provided. The geological reserves of the existing mines cover this amount without difficulties

• Kosovo will meet domestic energy demand and start later on to export energy based on lignite (so it will enter in South East European Regional Market) after construction of new TPPs (350 MW-units) for electricity supply into REM (Regional Electricity Market); the start of production of the Thermal Power Plant is predicted to be year 2016. In this regard since 2012 the Mirash East will support actual mines until 2015 when South Siboc field will be the main supplier for new and existing energy production capacities.

Chapter VII

7. SUSTAINABLE MANAGEMENT AND DEVELOPMENT OF GUIDELINES FOR LONG TERM PLANING FOR LIGNITE BASED ENERGY SUPLY OF KOSOVA

7.1. Database of Lignite Resources

Undoubtedly the largest part of the lignite reserves in the Republic of Kosovo is located in the Kosovo-Basin. Observed in the long term, such amount of balance sheet reserves and a much more favorable proportion of open pits and coal than in other basins, make the Kosovo Basin the most important energy potential of the country in the following period. Lignite contributes to economic development primarily through its wide use in electricity generation and steel production. The pervasive use of electricity in many different economic activities makes it the most important energy source for economic development of the country.

Lignite fired power is a competitive electricity technology, due mainly to the relatively low cost of lignite. The abundance of lignite, ample prospects for mine productivity improvements and the competitive nature of the traded lignite market ensures that lignite fired electricity will remain a competitive option. However, the affordability of lignite in the future will depend on policies designed to internalize both positive and negative externalities such as environmental impacts, energy security and energy safety. In the short to medium-term, despite improvements in technology, alternative energy technologies will, in many circumstances, are not competitive with existing conventional technologies such as those for lignite, making the reliance of electricity from these sources limited. The contribution of lignite to social development can be divided into issues related to lignite production and lignite use in electricity production. Lignite mining is both land and labour intensive and hence there are a number of issues that affect the welfare of local communities (employment, constraining land uses, health and safety etc). The main contribution of lignite to social development is through its use in electricity generation, an important energy source for improving standards of living. Access to affordable energy is a driving force behind economic development. For developing economies that have a relatively high dependency on energy intensive production – such as metals and manufacturing – economic growth is more closely linked to energy consumption than in developed countries. However, to prevent the exhaustion of finite energy resources and meet environmental expectations – requirements for sustainable development – economic growth must become less reliant on energy consumption. The resource calculation is spreaded in short term through active mines Bardh and Mirash, continuing in middle and long term to the areas of Siboc, D-Field and “South-Field”, Dukagjini and

Drenica basins as potential resources for future supply. In the assessment for lignite reserves it is very important to define some key points which are necessary to give clear options for further work. This key point includes:

- Verification on the quality and quantity of economically exploitable lignite reserves.
- Elaboration of Lignite Market in domestic and regional level
- Determination of the future lignite production level in part by domestic and the regional demand and supply of thermally generated electricity capacities and in part by lignite demands by industry, households and other possible users
- Mine development Planning-for middle and long term period which includes definition of primary, secondary and tertiary fields according to their importance
- Mine planning should take into consideration the regional, geological, mining, environmental and spatial impact, optimum equipment utilization and definition of areas from interest.
- Environmental issue by new mine development have to comply with best EU practices
- Review of the impact of future mining in terms of resettlement, land use, groundwater availability, air pollution (through smouldering mine fires) and possible other environmental aspects and the production costs

All this points are part of later options given in this work and are fully analysed by scenario settings and played a important role in the conclusions for further steps to ensure secure supply of energy for Kosovo abased in domestic fossil fuels. During long work and data collection there are received 498 drill hole logs from geological institute-INKOS. The logs have been set up during various drilling campaigns since 1952.

Generally the drill holes are located along east-west and north-south sections at a distance of 250 m. The received logs cover the following areas:

- Mirash
- Bardh
- Siboc Field
- South Field,
- Field D
- Dukagjini Basin and
- Drenica Basin

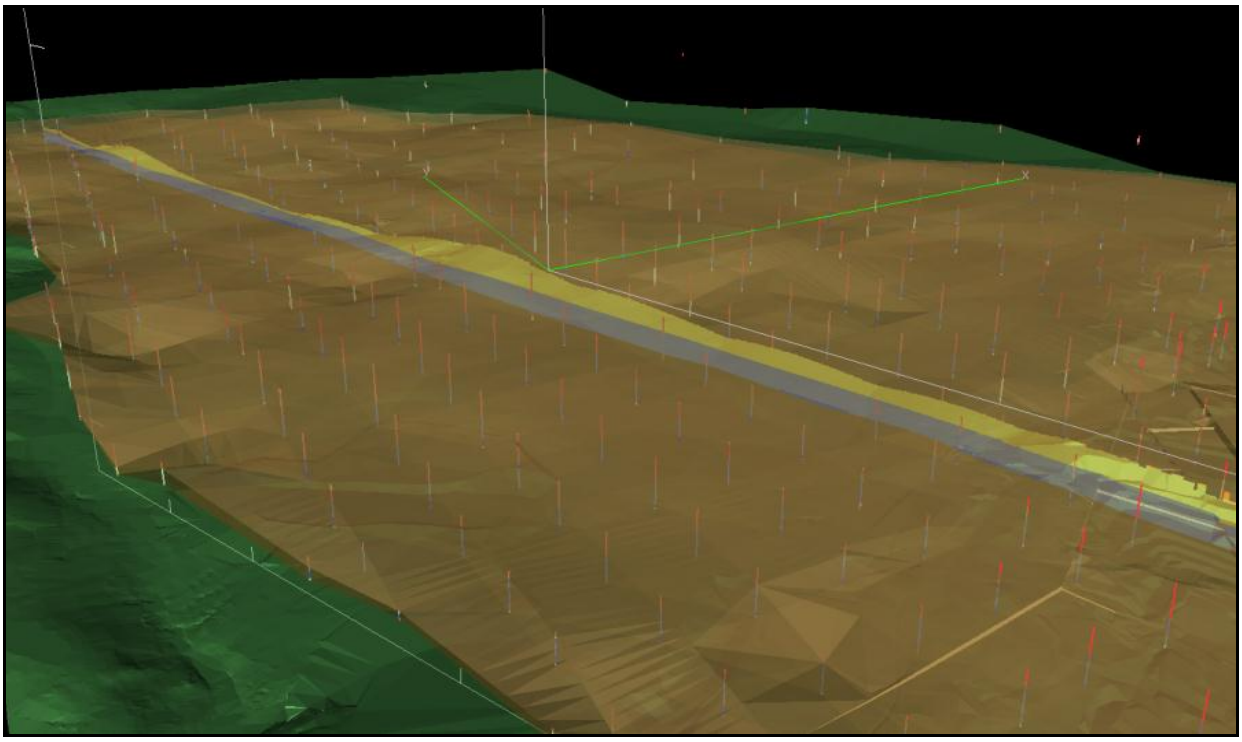


Figure 7-1: Boreholes in Siboc Lignite Field [25, 41]

7.1.1. Kosovo Lignite Basin

The basin of Kosovo lies in the central part of Kosovo and in terms of geomorphology and geography, the basin is known as areas of Fushe Kosovo, with a length about 85 km, and average width of 10 km. On the basis of existing documentation that the pond occupies an area of about 850 km^2, while it's productive basin part covers an area less than 300 km^2. Kosovo Basin has a developed network of road traffic, rail and other infrastructural facilities. In mining terms, settlements, the road infrastructure and railway traffic, has a special significance, because the usage of lignite basins is directly related to the solutions of constrain potentials that are through areas of exploitable fields.

7.1.1.1. Estimates for the Kosovo Basin

The geological reserves of lignite in the basin of Kosovo, were the subject of analysis from the past and because there was not unified opinion of present reserves the work is based in different figures that shows and estimates those reserves between from 12.000 up to 14.000 Mt. During 2007, the Institute INKOS has made a thorough analysis of preliminary estimates of geological reserves of lignite which were drawn from three different scientific institutions. In summary the results were presented and this data are relevant, within the geological area that in total includes 2359 drillings that were conducted, which occupy an area of

274 km^2. Simultaneously, the number of drilling which have penetrated the floor and which are made of quality analysis are 1000 drilling, of which 961 have shown the quality of lignite above 5450 KJ / kg.

The synthesis of the geological reserves of lignite in the Basin of Kosovo is presented in table below. Kosovo basin is in advantage compared to many other lignite basins with similar quality since the stripping ratio overburden/lignite is very favourable 1.76 m^3/m^3.

Mineable reserves (Mt)	8. 77
Unmineable reserves (Mt)	1. 32
Geological reserves (Mt)	10. 09

Table 7-1: Lignite Reserves in Kosovo Basin

The basement of the Kosovo Basin and the exposed surrounding areas are built up by Palaeozoic to Mesozoic crystalline rocks. The basin fill consists of Upper Cretaceous strata which are uncomfortably overlain by Tertiary clays of Pliocene age in which lignite is interbedded. Subordinated, Tertiary vulcanite's (andesite-dacite rocks) are distributed in Northeast of the basin. The Pliocene sediments can generally be subdivided in lignite unproductive areas in the north and south and a lignite productive central area. The central area, the "Kosovo Basin", is spreading out at a surface of approximately 300 km². Simply, the succession can be subdivided by grey and yellow clay on top, the underlying lignite formation and at the bottom the green clay. The geological and hydrological evaluation and interpretation was conducted over an area of some 92 km^2. It includes the mining areas of Siboc, the D-Field and an area to the south of the existing open cast mines, here introduced as the "South Field".

7.1.1.2. Siboc Field

Siboc field is most important lignite field that covers an area of 19.7km^2 and includes about 990 Mt of lignite, Mineable resources are 830 Mt with a stripping ratio 0.9:1 and average calorific value between 8200 – 8300 kJ/kg. The corresponding size of power plant is between 2000-2500 MW depending on the technologies that should be used.

In the future a new mine could be opened up in the area north of Bardh and Mirash fields while offers best connection to the existing mine. This mine would advance in northern direction. The existing lignite conveyors leading to the power stations could remain in the current position. A part of the old outside dump Shipitulla has to be excavated in order to uncover the lignite reserves. The overburden material can be dumped within the depleted mine areas Bardh and Mirash East and South Siboc. This will provide a filling-up of those areas to the original ground level for reclamation and final return of the land to the surrounding communities or for an exchange of land for future relocation of farms and/or settlements.

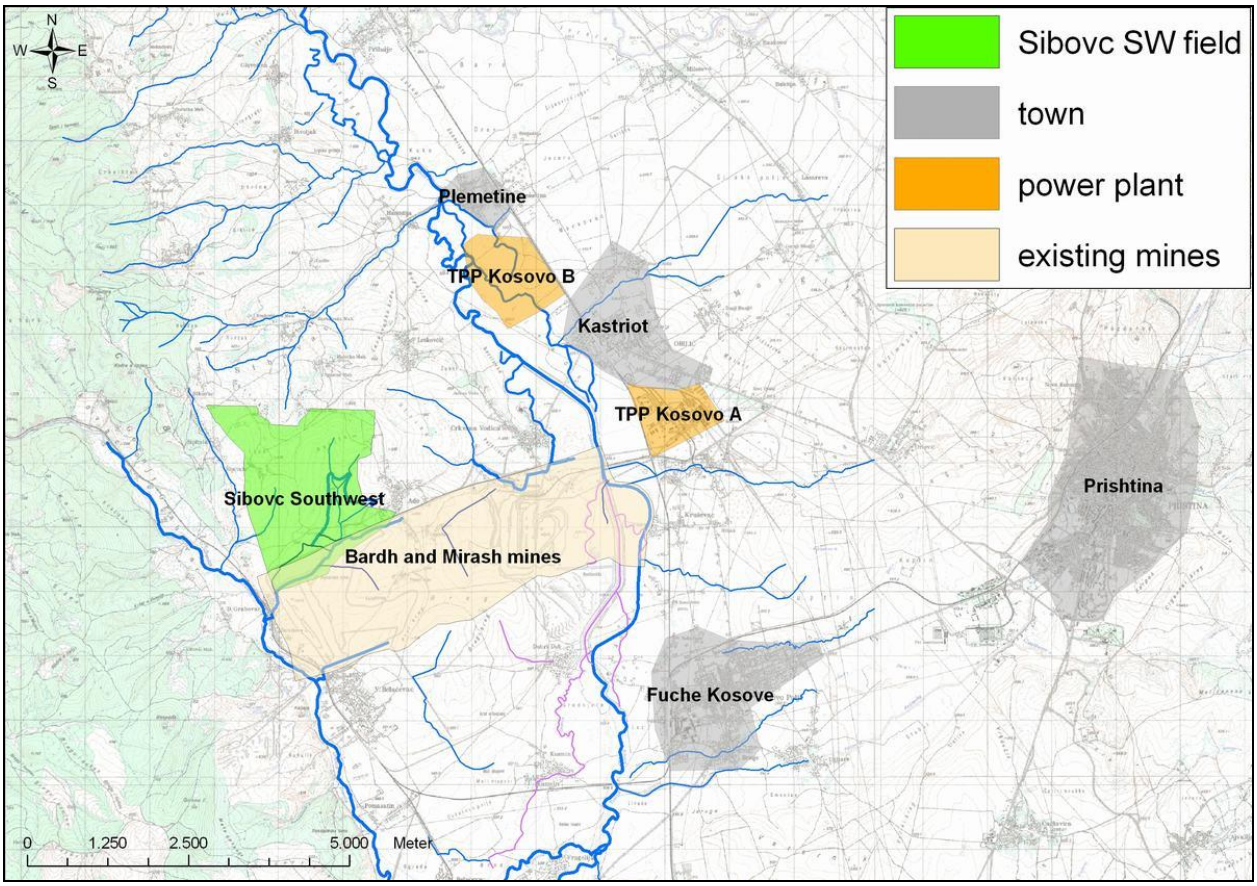


Figure 7-2; Potential Mining Fields-South Siboc Field, South Field and Field D [34]

7.1.1.3. South-Field

This area has the same geological and morphological characteristics. It comprises about 537 Mt over an area of 8.0 km^2. For south field 65 borehole data (litho logical descriptions, assay data) were available. A total of 27.731.7 m was drilled by these boreholes. The total depth is ranging between 11.8 m and 211.5 m with an average at 134.13 m. On the average the boreholes were drilled to some five meters into the green clay. The South Field directly borders on the existing Bardh and Mirash opencast mines in the South. In the West the mine boundary is formed by the village of Bardh and in the East the Sitnica River or the small town of Fushe Kosovo.

7.1.1.4. Field D

Field D s part of big Kosovo Lignite basin and there are deposits in amount of 395 Mt over an area of 7.8 km^2. Field D lies in directly beside the power plant TPP Kosovo A and ca. 5.5 km away (straight line) from

the power plant Kosovo B. In the West it borders the village of Dardhishte and in the South it boundaries with the small town Fushe Kosove including infrastructure like road and railway line, whereas the seam thickness thins out to below the economic limit into East/North-East direction and in parallel the lignite quality changes to the worth.

There exists a concession line which was also used for the comparison of the mining fields. A minimum distance between the villages was taken into consideration when choosing the mine boundary with regard to the before mentioned concession line. Already in the past lignite was extracted on the territory of field B. The major part was mined in underground mines. For example, 2.9 Mt of lignite was mined in the village of Dardhishte between 1948 and 1966. At present, a considerable part of those areas is used by KEK as ash disposal site. Furthermore, opening-up masses from the Mirash mine were deposited on this area. The dumped material is assessed to the ash Dump Dragodara. The recovery of the old dumps interferes with the excavation of the deposit. There are only few houses on lignite Field D. 226 borehole data (litho logical descriptions, assay data) were available for the area within Field D. The total depth is ranging between 9.80 m and 142.00 m with an average at 88.69 m. On the average the boreholes were drilled to some five meters into the green clay. The seam thickness is between 1.00 and 81.60 m. The average is at 58.17 m

7.1.1.5. Economic Assessment of Kosovo Basin

Taking into account the need for economical estimation of Kosovo Basin new research about lignite quality and overburden/lignite ratio is made and an economic assessment has taken place for each field separately and fields are assigned under priorities, by final ranking valorisation. By economical evaluation the primary criteria as a priority compared to other fields is the cost of production that will be achieved during the mining process, specified for 1 ton of lignite. On the basis of all assessments made so far, at a cost price of lignite extraction (operation coast) with surface mining technology, greater participation have costs that are formed during the main operation (the technology and disposal removal of the overburden and technology of mining and transportation of lignite). As second criteria it is taken into account fuel quality while as third criteria are evaluated costs for geological research in the area concerned. Thereof , based on these criteria, the highest priority areas will be ranked as first if there will take place less operating costs, second that will have higher calorific value and third(3) in which the need for new drilling would be small. Taking into account all estimates, regarding the projected operating, drilling costs and quality of the fuel, the exploitation of lignite fields can be dividing into:

- Area "A" total operating cost (euro / tons) 7. 29 first priorities.

- Area "B" total operating cost (euro / tons) 8.45 second priority.

- Area "B C1" total operating cost (euro / tons) 8.91 the third priority.

- Area "C1" totals operating cost (euro / tons) 13.65 priorities four. [11]

The average value of a cost price of lignite extraction within Kosovo basin is estimated € 10.83 / t.The total cost of operation it is estimated based on cost for the overburden removal (€ / m3) and mining (extraction) of lignite (€ / ton). Those analysis are made by the Institute INKOS, however the calculation of operating cost is dynamic category which practically should be determined by annual operating plans of the field exploitation.

7.1.2. Dukagjini Basin

Dukagjini basin lies in the north-east of the municipality of Klina and includes an area of 49 km^2 within the geological borders. This part of Dukagjini is covered by 19 settlements mainly distributed. From these settlements belong to the municipality of Klina, the Dukagjini basin needs to be more explored and it is important to mention that the town of Klina is located inside the lignite area of Dukagjini basin. To meet the knowledge of the Dukagjin lignite deposits it is necessary to proceed with new drilling and new research. Additional drillings may be performed by operators that will acquire the mining rights for exploration, based on transparent processes of selection and finalize the program of mining method and suggestion of final use of coal in the area concerned. White's Drini River flows almost through the middle of the basin. Within this basin the Kline deposit known as Tuçep area are very important and extends in direction of Peja on the left side of the White Drin River, between Klina and Tuçepi south to the north and hereafter will be used as Dukagjin basin. Larger settlements in this area are around the town of Klina About 30 km distance of the researched area is the city of Peja as administrative cultural centre for this region.

There are two potential Mining Areas to offer the most favourable mining conditions. Those areas that have been explored allows the preparation of long term plans and studies on the vial ability of open cast mining operation in the future. The mention areas are located within a walleye. Area 1 is characterized by presence of infrastructure and is close to the Village Tucep, about 5 km northeast of the city of Klina. This area covers about 6 square km compared to Area 2 that covers over 11km^2. Dukagjini basin position itself has good communication links. On the south side passes rail line that connects Fushe Kosove with Peja with a branch that leads to Prizren. The entire basin is crossed by paved roads Peja - Gurakoc - Mitrovica, Peja, road Kline - Prishtina, with paved roads Gurakoc - Kline. Since Dukagjini basin has developed a network of road and rail traffic during the exploitation of lignite basins should be provided solutions to deviation of infrastructural facilities, those which lie within the areas of exploitation.

7.1.2.1. Estimates for the Dukagjini Basin

Dukagjini basin is characterized by a low degree of geological research works in comparison with Kosovo basin. Thereof raises the need for research work – in geological field, geological drillings in a regular network, the density of which would ensure complete and competent information on all the geological elements, which would achieve the required safety in the treatment of lignite reserves. Geological research

should continue towards the town of Peja, Gjakova and Prizren while there are clear indications that in these areas can be explored new lignite deposits. According to the calculations that are based in actual data it is determined total volume of 5.915billion m^3 overburden. The overburden/lignite ratio is 3.24 m3/m3 of lignite and below is data about geological reserves of lignite in the Dukagjini Basin.

Mineable reserves (Mt)	2 047.69
Unmineable reserves (Mt)	197.13
Geological reserves (Mt)	2 244.82

Table 7-2: Lignite Reserves- Dukagjini Basin [2]

7.1.2.2. Economic Assessment of Dukagjini basin

Based on preliminary data, a definitive economic assessment is made through calculation and regarding to this also ranked. The basic criteria for the Dukagjini basin are the same that are used as well for Kosovo lignite basin estimations. Criteria like land use, geological reserves, production cost of lignite during the mining process specified for one ton of lignite. As second criteria it is taken into account the fuel quality while the third criteria include costs for geological research in the area concerned. Thereof based on these criteria, the highest priority areas will be ranked as first (1) if there will take place less operating costs, second (2) that will have calorific value and third (3) if the need for new drillings would be small. Taking into account all estimates, regarding the projected operating, drilling costs and quality of the fuel, the exploitation of lignite fields can be divided into:

- Area_1 with total operating cost 9.70 (euro / ton) represents 2nd priority

- Area _2 with total operating cost 9.03 (euro / ton) represents 1st priority

Based on the analysis so far compared to the Kosovo lignite basin, Dukagjini basin is less explored and analysed so it can be concluded that the Dukagjin basin and mining activities would have an in-depth analysis for developing of these activities, considering all impacts possible, particularly in terms of economic impact - in the agricultural region.

7.1.3. Drenica Basin

Drenica basin lies between the basin of Kosovo to the east and Dukagjin basin in the west with a total area of 3.97 km^2. This basin characterizes two areas: Area of Skenderaj and Areas north of Gllabari village in southern direction of the Drenas city. Hydrogeologicaly all waters from River Drenica flow in into the White

Drin. The communications links with other centres are good. Deposit of lignite fields in Drenas and Skenderaj are linked through roads that connects Drenas with Skenderaj, road Pristina-Mitrovica-Peja and Podgorica. As well railway connection between Pristina and Peja passes through Drenas are without direct impact in lignite deposit areas. Based on geological data presented the maximum heating value of the lignite is in southern-central part 9213 kj/kg and the average 7117 to 7955 kJ/kg, while the minimum heating value is 4188 kJ/kg, in the eastern part.

From 44 drillings conducted from 1965-1980 with total length 1790 m, they have provided elements for the possibility of defining the border of deposit and calculating the reserves. The thickness of the overburden drilling on average is 35 m and the average thickness of the layer of lignite is 23.02 m. Criteria for defining reserves are the same that were used for the Kosovo basin and Dukagjini basin. According to calculations made so far, geological reserves in the basin of Drenica were: 106.63 Mt and of these, as reserves are estimated balances 73.18Mt. On the other hand for the same basin overburden measures are: 69.503.403.20 m^3, where the stripping ratio overburden / lignite is 0.76/1.

7.1.4. Other lignite basins

Being associated with data from previous geological research, there are indications that the lignite deposits can be presented in more locations in Kosovo. One of the potential sites is Dardana-Karaqevë surroundings. Within the Kosovo are shown lignite deposit indications in the territory of the Municipality of Ferizaj, in the municipality of Besiana etc. In the future should be planned and implemented new geological research for those areas. At the moment when this strategy is still not established these perspective areas, are not seen from particular interest to enter into any priority in the Mining Strategy.

7.2. Data for Land Use

For a further investigation of the deposits with regard to environmental and regionally significant aspects of the surface use is taken into account in order of competing uses. This was the use of the geological and geographic information system for the representation and analysis of potential constrains. These analyses were made mainly about the areas of settlements, protected areas, infrastructure and water.

In the addition to the above, data has been used for the extension of the special economic interest area. The possible new mining fields have been elaborated in the spatial context of the Region and Kosovo. The available information, are grouped below into four major areas of settlements, protected areas, infrastructure and other possible usage areas and described in more detail below.

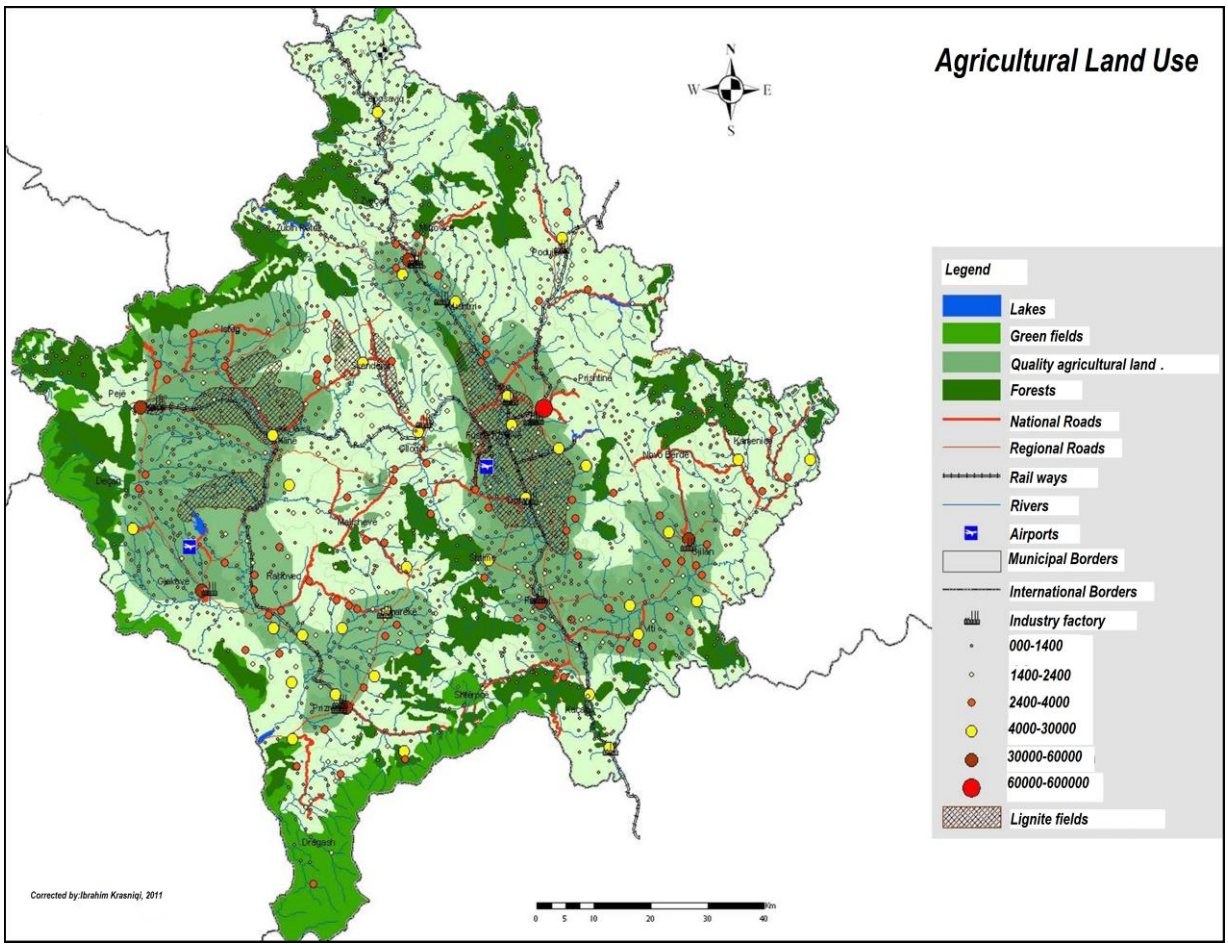


Figure 7-3: Occupation of qualitative agricultural land [3]

7.3. Settlements

Kosovo is listed among the first countries in Europe for its population density, with around 220 inhabitants / km². Large differences in economic development between areas in Kosovo are the main inducers of population movement and migration. A large part of settlements, especially those located in mountainous areas, are faced with very poor rates of economic development.

7.3.1. Settlement Distribution

There are over 2 million inhabitants living today in Kosovo, distributed in 1457 settlements, of which 36 are of a municipal level, while others are settlements which carry a village status based on activities and contents. Settlements are mainly distributed all over the Kosovo area, the majority (53%) or 63% of the population living in sea levels up to 700 m, while the other part living in settlements at sea level of above

700 m, lacking social infrastructure and services. Lacking these services, parts of the population from these settlements have moved to more developed settlements, in search of better housing conditions. Uninterrupted movement of population has caused a concern of over-loading in urban areas, which, in the absence of plans are being developed without any control of construction and spatial development. As about settlement structure, especially in central, mountainous and border areas, settlements are characterized by a poor social and other sector development. These areas are increasingly being endangered by depopulation, and orientation towards more developed centres and big cities. The population in the lignite fields have the greatest importance, while they have the reduction impact in a commodity that may cause necessary relocation and raise cost. So far they provide the greatest potential for constrain and cause for this reason, the location of settlements and the number of inhabitants' impacts directly in the border shape of possible lignite fields.

7.4. Natural Protected Areas

The second major constrain with a potential extraction is caused by existing protected areas. For this reason, the most important types of protected areas are taken into account. Information to the studied protected areas are from the spatial planning Institute and are of current standard in the range of protected information on landscape, nature conservation, water protection, habitats and birds were considered. The available data include the name and location and extension of area of the various protected areas. However there are still problems in data collection while in some areas is lack of information's and spatial planning.

The Law on Nature Conservation (2004) does not contain specific provisions for the institutional arrangements to be envisaged for the Management Body of the Protected Areas (organizational structure, statute, composition of the management) nor does it clearly indicate which Institution should finance the Management Body' s costs (personnel, equipment, facilities, running costs, etc. The Law assigns a critical role to Municipalities that includes establishing the management authority for all categories of protection, except for National Parks. It is recommended to verify and ensure that Municipalities possess the necessary capacity and resources to comply with these requirements.

7.5. Infrastructure

A third potential constrain provide existing infrastructure such as roads and railway lines. In the area of infrastructure, therefore, detailed information on roads and railway lines were used. As with the previously described aspects of settlements are respected and protected areas for the subsequent planning of infrastructure and minimum distances to the proposed mining areas. This minimum distance is settled according to the Law on Mining and Minerals [48].

7.6. Water Supply

The Kosovo Water Law under Section 8 calls for coordination of river basin management with upstream and downstream riparian in the case of trans boundary river basins system. It appears from the Law that industrial complexes, unlike irrigated agriculture and fisheries, are not eligible to apply for a water concession, although the law states that "use of water for technological needs" is eligible to apply for a concession. There is a need for a river basin plan and comprehensive policy framework to guide strategic water allocations to various sectors and define and institute mechanisms for resolution of competing water demands.

The power plant will need raw water 1 364 m3/h per 500 MW, i.e. the fully built 2 000 MW plant would consume about 5 500 m3/h (1, 5 - 1, 6 m3/s), which amounts to 42 900 000 m3/a. Most of the water, approximately 90 %, would go to the evaporative cooling tower. All the water received needs pre-treatment (softening and filtration) before it is used at the plant. The water is coming to the Prishtine area through separate systems: The city of Prishtina receives its water from the Rivers Batllava and Lap. Those rivers also feed Kosovo A power plant 1 - 2 m3/s from the pumping station in Brukovc village 4 km to the northeast of the plant.

There is also the possibility to complement the water supply by 3, 3 m3/s from Iber-Lepenc multipurpose (irrigation and industrial use) system built in the 1970's. It originates from Lake Gazivode in the north-western corner of Kosovo. Partly the lake is beyond the border. The lake has a storage capacity of 350 million cubic metres. The water is coming through a 50 km long channel system. Mostly it is made of open concrete lined channels and partly in conduits crossing valleys etc. The water supply system is operated by Ibër-Lepenc, a public enterprise created for the task. Originally the water supply system for Kosovo B plant has been designed for 21 000 m3/h (5, 8 m3/s). Currently the plant uses around 1 500 m3/h (0, 4 m3/s). At the Kosovo A site the current water usage could be transferred to Kosovo C as the plan is to close down the old power plant. The used water volume is almost sufficient for the new much larger capacity plant due to its better overall efficiency

7.7. Air Quality

The area around actual mining activities is much polluted and this is hug problem because of the density of population. As well the distance of country capitol is very small, just 15 Km that make this problem even greater. The main pressures on air are related to:

- emissions from lignite mining activities;
- emissions from lignite fired power plants;

• emissions from ash disposal;

• emissions related to traffic and heating systems, especially in Prishtina region.

Thereof is very important that dispersion of future activities has to be foreseen as a crucial factor. The determination factor is to fulfill the EU requirements in term of air pollution limits and this is hug challenge for Kosovo. This because of old inherited technologies in both, mining and generation sector results In middle and long term view this approach has to be changed and the new technologies should be used in order to improve the air quality.

Figure 7-4: Air pollution in the existing mining activities

7.8. Other surface uses and different specific factors

To estimate the potential of constrains in order to establish the development guide for future lignite activities in Kosovo, except above mention parameters, there are taken as well important impact factors like total area consumption for mining activities, geological data, stripping ratio between overburden and lignite quality, quantity, extraterritorial areas and economic impact. For this purpose, specific parameters for each possible mining area are calculated.

7.9. Data Quality

The study is based in personal experience and involvement in the different work studies and sources. The data-base regarding the thickness of the lignite seams encountered in the studied deposits are taken from Mining Faculty, Research Institute INKOS and other relevant sources. For an estimate of the population in

the affected villages at the time of viewing current community there are used data from Statistical Office of Kosovo. Because in Kosovo was not official census for more than 30 years, the approximation methodology was used. Therefore, for the determination of the specific constrains for those settlements with a population approximately are calculated all necessary figures. The data on the course of surface water is incomplete and not detailed. In some areas, the true course of the waters, are not only inaccurate, but they are missed even in the topographic maps.

The data on the railway lines are insufficient. Some of lines are shown on the topographic maps for which there are no vector data. The same must be noted that the data basis for further infrastructure facilities in the form of the road network is not complete. Some roads are missing from the existing data between individual villages that exists in the topographic maps. The type of these roads is not covered is unclear. There are insufficient digital data including highways, country and regional roads. In general, must be noted that the quality of the data is very heterogeneous. A further review of the data relevance and an additional data collection was not part of this work.

Chapter VIII

8. RISK FACTOR AND CONSTRAIN ANALYSIS AS POTENTIAL LIMITATIONS FOR FUTURE MINING AND GENERATION ACTIVITIES

Constrains in large lignite basins emerge in consequence of large-scope exploitation and transformation of lignite, but that does not exclude other causes of constraining interests in these areas. The area of Kosovo lignite basin most prominently reveals the following constraining interests, exceptionally high overall and especially agrarian population density (among the highest in Europe), insufficient and uneven development of the country, infrastructure and natural protected areas within deposit borders.

The constrain analysis of the deposits, the credit ratings are assigned to the high, medium and low important areas, for each subject field. First, the potential mining areas are considered as potential constrains with human beings. The field boundaries are directly impacted from human settlements, so that results with a reduction of the field and any necessary relocation can be made just after very carefully study. In relation to the total population of the settlement then, the number of the affected residents will be charged. Following the consideration of the settlement areas after constrain analysis and score factors are designated protected areas. In this regard, infrastructure facilities such as highways, national and regional roads are taken in the focus of consideration.

This has considered only the present infrastructure in the areas. However, the length of new roads to be build in future plans is therefore not part of this investigation. Finally, the conflict potential of the other land uses will be considered. Unlike the first constrain considered human beings, protected areas and infrastructure, the constrain potential about other land uses will be considered only qualitative [21]. There are no specific values calculated and the deposits are not classified with regard to these constrains in a ranking. The constrain analysis of other surface uses is therefore only the creation of a survey of other constrains that may occur, which are to be considered.

In final ranking of fields the fuel quantity and quality are taken as well into consideration and in some cases are determinant factor of ranking. Must be noted at this point that flowing surface waters such as streams or rivers, no consideration in the constrain analysis found, because the existing database was inadequate for this purpose.

8.1. Siboc Field

Siboc field is most important lignite field that covers an area of 19.7km^2 that includes about 990 Mt of lignite, Mineable resources are 830 Mt with a stripping ratio 0.9:1 and average calorific value between 8200

– 8300 kJ/kg. The corresponding size of power plant is between 2000-2500 MW depending on technologies that should be used.

This new mine would advance from South Siboc in northern direction. The existing lignite conveyors leading to the power stations could remain in the current position. A part of the old outside dump Shipitulla has to be excavated in order to uncover the lignite reserves. The overburden material can be dumped within the depleted mine areas Bardh and Mirash East. This will provide a filling-up of those areas to the original ground level for reclamation and final return of the land to the surrounding communities or for an exchange of land for future relocation of farms and/or settlements.

There are 26 settlements within the interest area, which are directly or indirectly affected by expected developments in construction and operations of generation units, ash transport and deposit, mine expansion and lignite transport, electricity transmission and distribution capacities. Settlements spread over the lignite reserves, and directly affected by mining development processes (overburden mining, lignite mining and extraction) are: Hade, Siboc, Shipitulla and Lajthishta. Apart from these, the village Palaj and Zhilivode should be dislocated, as well although there are not many reserves under it, but those villages are directly affected. The settlement constrain data are given in the table below.

Siboc Field	Inhabitants	Number of affected inhabitants	Affected inhabitants[%]
Hade	2892	2892	100
Lajthishte	1284	1284	100
Siboc	2018	2018	100
Palaj	1147	670	58
Zhilivode	1092	875	80
Summary	8433	7739	92

Table 8-1: Settlements affected by Siboc Lignite Field

Housing and built areas for shelter of population in settlements within the area cover around 11% of the total area of this zone, namely covering around 1.702 ha. Obiliq and Fushe-Kosovo towns are two urban centres, and municipal centres of the area. All other settlements of the interest area are mainly of rural character, namely villages inhabited by population working mainly with agricultural activities. Infrastructure in the Siboc area – Road transport to and from the Siboc area is organized by easy access connections to the national road M2 Prishtina-Mitrovica and M9 Prishtina – Peja, which are also north-eastern and southern borders of the area.

Siboc Field	Data
Total Area [km^2]	19.7
Geological Lignite Resources [Mt]	990
Mineable Resources [Mt]	830
Stripping Ratio	0.9:1
Average Calorific Value]	8.3
Corresponding Size of TPP [MW]	2,000 – 2,500
Inhabitants/ Number of affected inhabitants and [%]	84333/7739/(92%)
Regional dispersion of lignite resources from actual mining-distance[m]	No
Water availability	Yes
Economical Impact	Yes
Extraterritorial jurisdictions of communities{Ha]	65
Highway(m)	0
Regional and local road (m)	15567
Distance of lignite from PP (m)	750
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	250
Natural protected areas(Ha)	520

Table 8-2: Data about Siboc Field

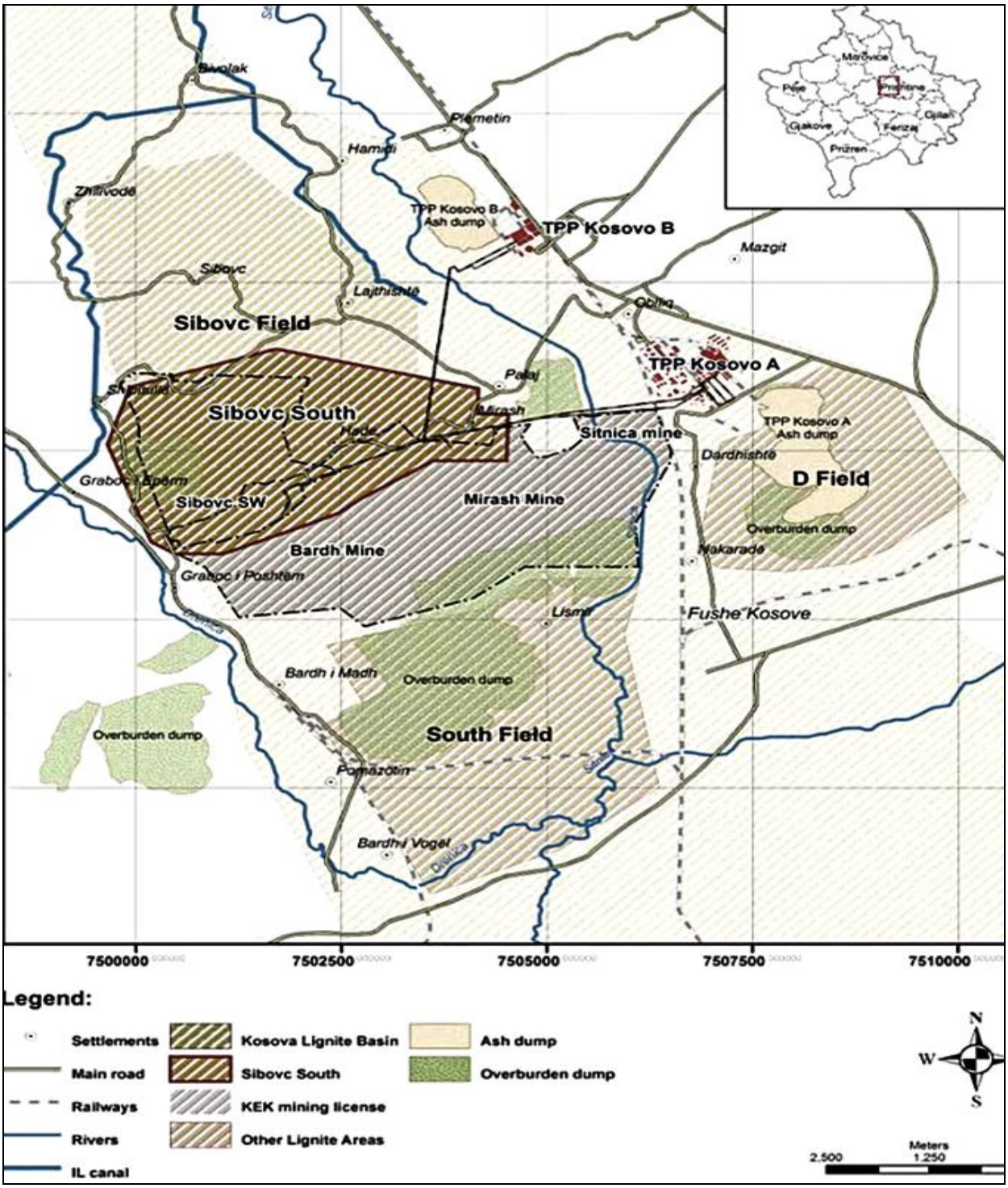


Figure 8-1: Siboc Lignite Field [34]

Here it is important to underline the direct connection with the Merdare – Morina highway which is expected to be built soon, and shall pass through the special economic interest area, respectively its south-eastern

corner. However this is not included in this research work. Other connections or main roads passing through the area are: regional road R220, which goes through villages of Prilluzha, Plemetin, Obiliq and Dardhishta and connects to the M2, and the regional road R120, dividing the mining area into two halves, coming from M2 and going through Obiliq, Palaj, Hade, Lower Graboc, Bardh I Madh, and to Sllatina Vogel, connecting to the M9. Other roads are local, connecting settlements within the wide area of the NMF, such as: the road around the new mining area: Prilluzha, Gllavotin, Bivolak, Zhilivoda, Upper Grabovc and to Lower Graboc, and roads connecting Obiliq and Plementin towards Lajthishta and Siboc, to continue to Hade, namely Shipitulla, and up to Zhilivoda and Upper Graboc. Also, there are several other roads of this level in the special area, connecting settlements with their urban centres and other settlements of their municipalities. Since the R120 road has been cut due to mining activities in the northern corner of the existing Bardh mine, a substitute road has been built. As well Siboc Field includes a large natural protected area that is spreded in different places. One crucial aspect is extraterritorial juridicsstion of some parts that represents challenge for future activities in those areas. Water availability is present from Iber-Lepenc hydro system and the economic impact is very large, cause by hug deposits in the Siboc field. Below is a summary of different important data that finally helped to define the ranking of fields in order to secure sustainable fuel supply for future energy generation in Kosovo.

8.2. South Field

For south field 65 borehole data (litho logical descriptions, assay data) were available. The total depth is ranging between 11.8 m and 211.5 m with an average at 134.13 m. On the average the boreholes were drilled usually to some five meters into the green clay. The South Field directly borders on the existing Bardh and Mirash opencast mines in the South. In the West the mine boundary is formed by the village of Bardh and in the East the Sitnica River or the town of Fushe Kosovo. The area covers more than 8km^2 and includes about 537Mt of lignite, where mineable resources are 370 Mt with a stripping ratio 2, 8:1 and average calorific value between 8000 – 8300 kJ/kg. The corresponding size of power plant is about 1000 MW.

South Field/ Area E	Inhabitants	Number of affected inhabitants	Affected inhabitants (%)
Mesbardh	697	585	84
Lismir	1250	1135	91
Kuzmin	565	545	96
Total	2512	2265	90

Table 8-3: Affected Inhabitants for South Field

South Field	Data
Total Area [km^2]	8
Geological Lignite Resources [Mt]	537
Mineable Resources [Mt]	370 (69%)
Stripping Ratio	2.8:1
Average Calorific Value]	8,000-8,300
Corresponding Size of TPP [MW]	1,000
Inhabitants/ Number of affected inhabitants and [%]	2512/2265/(9%)
Regional dispersion of lignite resources from actual mining-distance [m]	No
Water availability	Yes
Economical Impact	Yes
Extraterritorial jurisdictions of communities{Ha]	15
Highway(m)	0
Regional and local road (m)	3567
Distance of lignite from PP (m)	1250
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	750
Natural protected areas(Ha)	150

Table 8-4: Data about South Field

In regard of the infrastructure there are two railway lines going through the interest area. One is the Shkup-Fushe-Kosovo-Mitrovica line, with stations Dardhishta, Obiliq and Plemetin, and the other being Fushe-

Kosovo – Peja line, with railway stations in Kuzmin, Bardh Madh, and Upper Graboc. One must underline that Kosovo A and B power plants are also connected with railway lines. Below are data for this field that includes potential constrains for inhabitant resettlement, protection areas and other important figures.

Other Constrain Potentials

Major obstacle in this sense is existing waste rock dump that covers large surface over lignite deposits and is necessary to be taken into account by the evaluation of this field. Compared with the Siboc field the overburden volume doubles. In general there is the tendency of the overburden lignite ratio to change to the worse into Southern direction. In addition to the geological overburden, large amounts of dump material will change this ratio further to the worse. These dumps comprise a total volume of 90 to 110 Mm^3 (slope angle ca. 6°) of an entire area of 5.5 km^2 and an average dumping height of 20 to 30 m. The dump soil is very difficult to excavate. Besides the problems in the excavation and transportation process, there are considerable problems of static stability for the slopes to be built. This will have as well hug impact in final ranking of the fields. The quality of fuel is good and extraterritorial jurisdiction area is less than by pervious field. Here the water supply problem is not present and the economical impact benefits are considerable. Existing mining and generation infrastructure is close enough although that das not allow the regional dispersion of future activities in geological mining activities and this will bring minus points for this lignite field.

8.3. Field D/Area D

Field D covers an area of 7.8 km^2 and includes about 395 Mt of lignite. From this amount mineable resources are 280 Mt with a stripping ratio 0.9:1 and average calorific value about 7300 kJ/kg. According to those data the corresponding size of power plant is about 600MW. Approximately 226 borehole data (litho logical descriptions, assay data) were available for the area within Field and a total of 105,399.70 m were drilled by these boreholes. The total depth is ranging between 9.80 m and 142.00 m with an average at 88.69 m. On the average the boreholes were drilled to some five meters into the green clay. Almost the same constrains and conditions compared to South Field with water availability supply for future activities and similar economical benefits.

Other Constrain potentials

One other important constrain potential is existing off as dump that covers large surface over lignite deposits and is necessary to be taken into account by the evaluation of Field D. Already in the past lignite was extracted on the territory of Field D. The major part was mined in underground mines. Furthermore, opening-up masses from the Mirash mine were deposited on this area. The dumped material is assessed to the ash dump Dragodara. The recovery of the old dumps interferes with the excavation of the deposit. The extraterritorial jurisdiction areas are approximately 10 Ha and the existing infrastructure is not far from the field.

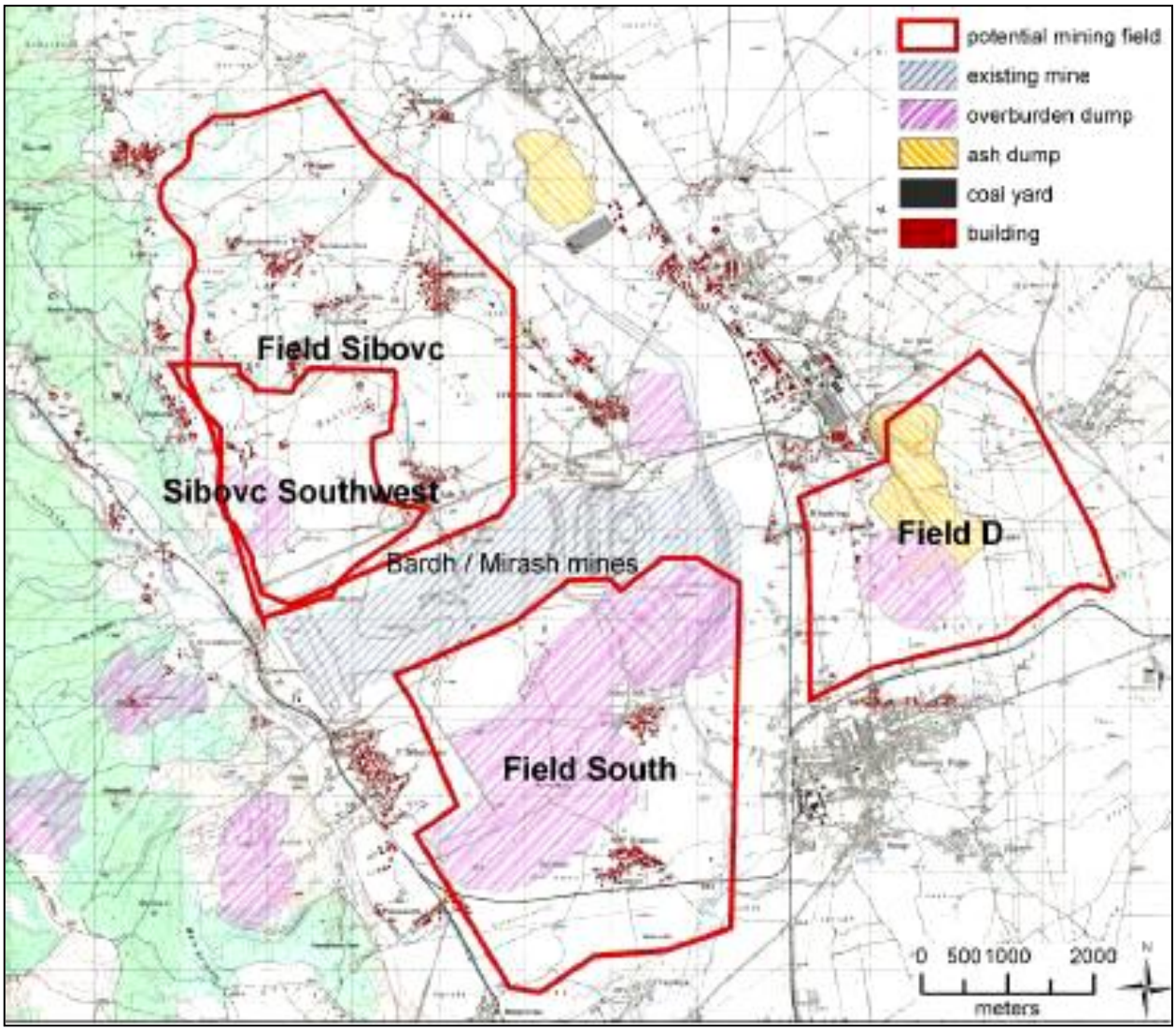


Figure 8-2: Complemented Extract from Siboc, South field and Field D- Map [34]

Field D	Inhabitants	Number of affected inhabitants	Affected inhabitants[%]
Dardhishte	2210	2210	100
Nakarade	1760	1760	100
Total	3970	3970	100

Table 8-5: Number of affected inhabitants in Field D

Field-D	Data
Total Area [km^2]	7.8 km^2
Geological Lignite Resources [Mt]	395
Mineable Resources [Mt]	280 (71%)
Stripping Ratio	0.9:1
Average Calorific Value]	7,300
Corresponding Size of TPP [MW]	600
Inhabitants/ Number of affected inhabitants and [%]	3970/3970/(100%)
Regional dispersion of lignite resources from actual mining-distance[m]	No
Water availability	Yes
Economical Impact	Yes
Extraterritorial jurisdictions of communities{Ha]	10
Highway(m)	0
Regional and local road (m)	5567
Distance of lignite from PP (m)	850
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	950
Natural protected areas (Ha)	255

Table 8-6: Data about Field D

8.4. Kosovo Basin Southern Part

Because of the complexity of this part and large number of inhabitants, infrastructure and other facilities it is analyzed as a whole. There is very large amount of lignite deposits but those are in an area where the density of population is very high and therefore it is tried to divide this large basin in different areas. Also the total area covers large territory with 139 Km^2 and ability to produce some2 600Mt of lignite, that is large amount and capable to supply over 4000 MW of generation capacities over their long life cycle.

However this part is far from water supply capacities that count as negative constrain factor and also extraterritorial jurisdiction areas cover large part of lignite field almost 710Ha. Even that is not far from existing mining and generation activities this basin lacks direct connection to the existing mines while there are located between large habitant areas like capital Prishtina and Fushe Kosova town. Except the dense population the area of Kosovo basin southern part is very dense as well with infrastructure and other public facilities. Independent of that here are described the main characteristics in different areas.

8.4.1. Area F

.Area F is located directly south of South field area covers an about 18km^2 with an estimated mineable area of 5.4 km^2. It includes about 430 Mt of lignite, with a stripping ratio 1, 7:1 and average calorific value about 8150 kJ/kg. The corresponding size of possible power plant is about 760 MW. Area F is characterized by dense population within number of villages and the junction of rivers Sitnica, Drenica, Prishtevka and Gracanka in northern part.

8.4.2. Area G

Area G is located directly south of the river Prishtevka and is limited by the boundary of lignite deposits in east. It covers an about 22 km^2 with an estimated mineable area of 15 km^2. It includes about 1030 Mt of lignite, with a stripping ratio 1, 2:1 and average calorific value about 8150 kJ/kg. Mineable reserves are about 720 Mt and the corresponding size of possible power plant is about 1600MW. Area G is characterized as well by dense population that is concentrated within number of villages along the Gracanka River. It is assumed that the river and settlements are not to be relocated.

8.4.3. Area H

Is located directly south of the Area F and is limited by the boundary of lignite deposits in the west. In the east railway tracks have been selected as borders and the total area amounts to about 24 km^2 but only 19% of Area H provide stripping ratio less than 2:1. It includes about 260 Mt of lignite, with an average calorific value about 8150 kJ/kg. Mineable reserves are about 170 Mt and the corresponding size of possible power plant is about 430MW. Area H is characterized by dense population that is concentrated within number of villages in the west of Sitnica River.

8.4.4.. Area I

Area I is located directly south of the Area G and west of Area H in the east. The total area amounts to about 22 km^2 where 73% of Area I provide stripping ratio less than 2:1. The average stripping ratio is 1.2/1 only. It includes about 620 Mt of lignite, with an average calorific value about 7300 kJ/kg. Mineable reserves are about 430 Mt and the corresponding size of possible power plant is about 980MW. Area I is not characterized by dense population and major surface obstacles are not present.

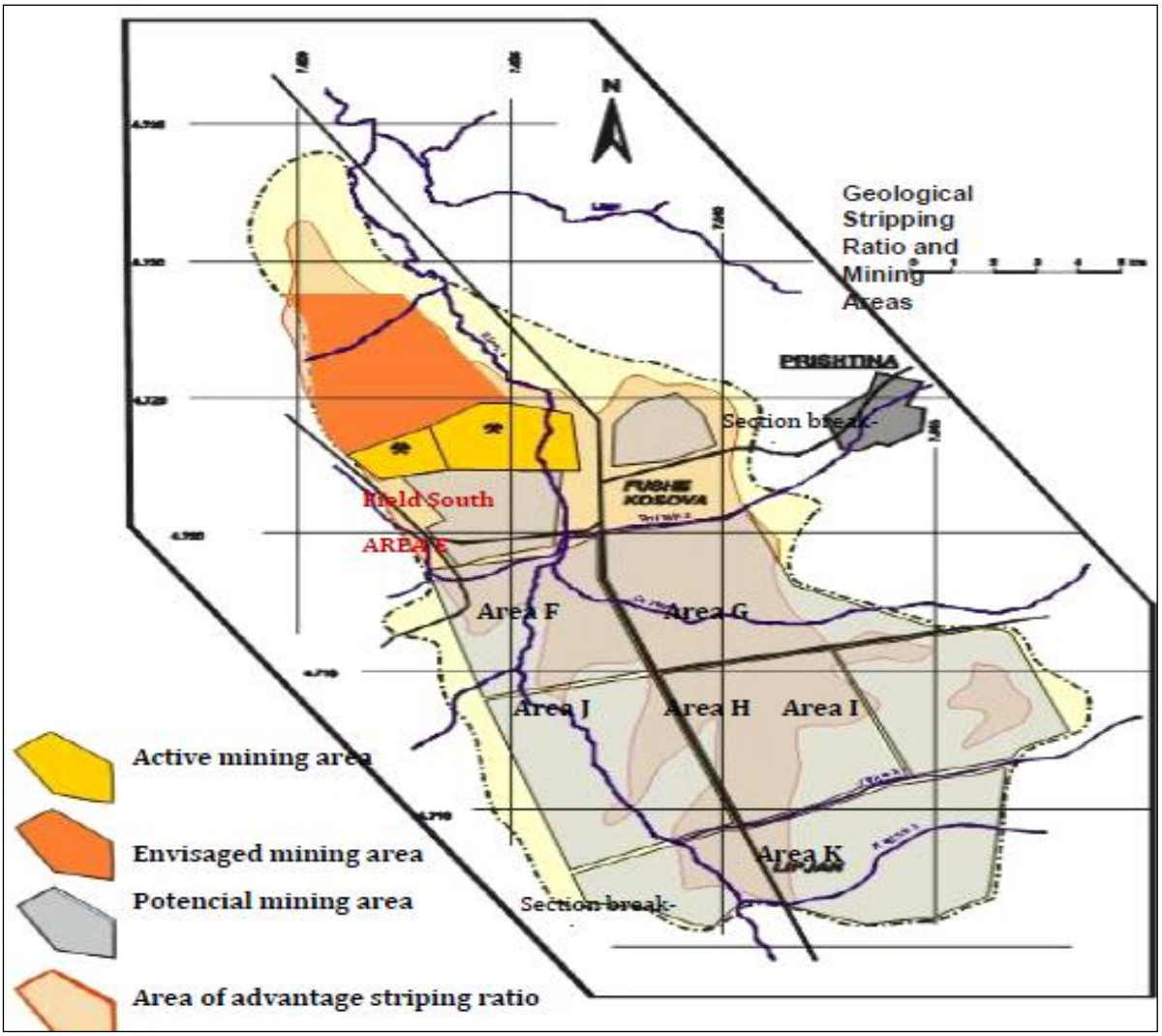


Figure 8-3: Kosovo Basin Southern Part

8.4.5. Area J

Area J is located directly east of the Area I and the total area amounts to about 19 km^2 where approximately only 25% of Area I provide stripping ratio less than 2:1. The average stripping ratio is 1/1

only. It includes about 160 Mt of lignite, with an average calorific value about 7300 kJ/kg. Mineable reserves are about 110 Mt and the corresponding size of possible power plant is about 250 MW. Area I is not characterized by dense population and major surface obstacles are not present, however lignite resources are very limited.

8.4.6. Area K

This area is located in the southern corner of Kosovo lignite basin. Area I in total amounts to about 33 km^2 where approximately only 3% of Area I is mineable and the average stripping ratio is 1:1 only. It includes about 100 Mt of lignite, with an average calorific value about 7300 kJ/kg. Mineable reserves are about 70 Mt and the corresponding size of possible power plant is about 160 MW. Area K is characterized by dense population and lignite resources are very limited. In all mentioned subarea there are different kind of constrains that includes almost all factors that are taken as impacts factor by Kosovo lignite valorisation Below are tables with data about possible constrain potentials, quality, quantity and other important figures which are important by the ranking importance of lignite fields.

Kosovo Basin-Southern Part	Inhabitants	Number of affected inhabitants	Affected inhabitants (%)
Fushe Kosovo	20054	20054	100
Sllatina vogel	550	470	850
Bresje	600	380	63
Uglari	1200	1200	100
Vragolija	600	580	96
Miradi e ulet	430	430	100
Henci	390	390	100
Batusha	230	190	83
Miradi e eperme	450	450	100
Prishtina	620 000	0	
Preoc	370	260	70
Lapla selo	2980	1780	60
Sushice	320	320	100
Lipjani	8800	8800	100
Radevo	375	375	100

Lepina	450	450	100
Lug	280	280	100
Dobraja e vogel	1700	1450	85
Dobraja madhe	1380	1130	82
Glanica	655	655	100
Skulanovo	430	430	100
Lugu I thate	550	450	82
Konjuh	1370	1370	100
Gusterica eposhtme	2150	2150	100
Dobrotin	1580	1580	100
Rufci I ri	970	970	100
Rufci I vjeetr	1090	1090	100
Torine	765	765	100
Poturoci	1230	1230	100
Ribari vogel	1345	1345	100
Hallaqi vogel	1420	1420	100
Hallaqi madh	1925	1925	100
Gracka e vjeter	985	985	100
Toplican	1340	1340	100
Glogoc	1530	1350	100
Bujan	1760	1300	76
Grack e vogel	860	860	100
Celopek	1645	1250	76
Llugaxhi	1870	1870	100
Total	66629	63324	95

Table 8-7: Settlements and affected inhabitants-Kosovo Basin-Southern part

Kosovo Basin Southern Part	Data
Total Area [km^2]	139
Geological Lignite Resources [Mt]	2600
Mineable Resources [Mt]	1800
Stripping Ratio -Average	1.34/1
Average Calorific Value (kj/kg)	7600
Corresponding Size of TPP [MW]	4180
Inhabitants/ Number of affected inhabitants	66629/63324
Regional dispersion of lignite resources from actual mining-distance[m]	3500
Water availability	no
Economical Impact	Yes
Extraterritorial jurisdictions of communities{Ha]	710
Highway and Railway(m)	54000+3600
Regional and local road (m)	38000
Distance of lignite from PP (m)	18500
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	16500
Natural protected areas(Ha)	29020

Table 8-8: Data for Kosovo lignite basin –Southern part

8.5. Dukagjini Basin

Dukagjini basin is the second largest lignite deposit in Kosovo. This lignite field is located in the western part of Kosovo and in total covers an area about 95 km^2. There are two potential fields that are recognized as Area 1 and Area 2. The average stripping ratio is 1.7/1 in Area 1 and 3.1/1 in Area 2. It includes about 240 Mt of lignite in Area 1 and 440 Mt in Area 2, with an average calorific value between 8400-8700 kJ/kg. Mineable reserves are about 170 Mt (Area 1) and 310 Mt (Area2). The corresponding sizes of possible power plants are about 450 respectively 840 MW for areas mentioned above. Area 1 is characterized by dense population and infrastructure. Further more the river Kujavca crosses the area from northeast to southwest. Area 2 has no major infrastructure and streams.

However the density of population is relatively high. As constrain is foreseen also the extraterritorial jurisdiction areas that presents large part of land here. While river Drin ii Bardhe runs through the area it is considered that there will appear no problems with water availability and this is very positive factor in this regard. While regional dispersion of future activities is positive recognized by this research this will be positively evaluated and impacts the final ranking of future field. Below are data that are relevant for the Dukagjini Basin.

Area 1- Dukagjini Basin	Inhabitants	Number of affected inhabitants	Affected inhabitants[%]
Tuqepi	675	675	100
Osojani	345	280	81
Total	1020	955	93

Table 8-9: Inhabitants within Area 1-Dukagjini basin

Area 2 - Dukagjini Basin	Inhabitants	Number of affected inhabitants	Affected Inhabitants[%]
Shtupeli	875	670	77
Kerrnica	765	765	100
Total	1640	1435	87.5

Table 8-10: Inhabitants within Area 2 -Dukagjini basin

Dukagjini Basin-Area 1	Data
Total Area [km^2]	49
Geological Lignite Resources [Mt]	240
Mineable Resources [Mt]	170 (~70%)
Estimated Average Geological Stripping Ratio [m/m]	1.7/1
Average Calorific Value [kJ/kg]	8400
Corresponding Size of Power Plant [MW]	450
Inhabitants/ Number of affected inhabitants and [%]	1020/955/(93%)
Regional dispersion of lignite resources from actual mining-Distance[m]	88500
Water availability	Yes
Economical Impact	Yes
Extraterritorial jurisdictions of communities{Ha]	110
Highway and railway(m)	0
Regional and local road (m)	12300
Distance of lignite from PP (m)	88500
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	86500
Natural protected areas(Ha)	1478

Table 8-11: Data about Dukagjini basin-Area 1

Dukagjini Basin-Area 2	Data
Total Area [km^2]	46
Geological Lignite Resources [Mt]	440
Mineable Resources [Mt]	310
Estimated Average Geological Stripping Ratio [m/m]	3.1/1
Average Calorific Value [kJ/kg]	8700
Corresponding Size of Power Plant [MW]	840
Inhabitants/ Number of affected inhabitants	1435
Regional dispersion of lignite resources from actual mining-distance[m]	85000
Water availability	yes
Economical Impact	70
Extraterritorial jurisdictions of communities{Ha]	110
Highway and railway(m)	0+13800
Regional and local road (m)	27500
Distance of lignite from PP (m)	950
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	9500
Natural protected areas(Ha)	178

Table 8-12: Data about Dukagjini basin-Area 2

Other constrain potentials

There are green field areas with no infrastructure for new energy capacities. As well the land is very productive as agricultural resource and probably in some parts of basin there is as well problem with unfavourable striping ration overburden lignite 1.9/1 that raises the extraction costs. Furthermore, the river Kujavca crosses the area from Northeast to Southwest. So there is possibility of potential constrains in the future that should be avoided maximally. In order to appraise the results for the Dukagjini basin, these need

to be compared with the results for the Kosovo Lignite Basin. In terms of stripping ratio and resource quantity, Area 1 provides mining conditions similar to the mining areas of priority in centre of Kosovo (Siboc, South field, Field D). Differently to that here are some disadvantageous due to a very high geological stripping ratio compared to all of the other analysed lignite zones. According to the data and analysis large amount of lignite reserves which are located in different parts of Kosovo remain the only reliable resources for energy development in our country with justified economic investments. Especially for long term developments areas like Dukagjini and Drenica basin shows important potential. Within Dukagjini basin there are also other different fields with different quality and quantity of lignite but most favourable zones are Area 1 located near Village Tucep and Area 2 located near village Shtupel. In those areas the lignite seam thickness in average goes to 32 m and quality is comparative with quality of Kosovo basin lignite (Siboc, Field D and South Field). Analysing the scenario that after 50 years the deposits in Siboc will be exhausted and parallel to that reclamation of land in old mines is realized than this two lignite fields (Dukagjini and Drenica) offer great possibilities to overtake the energy production based in domestic lignite for the period beyond.

This has the advantage because that part mostly is green field and not very dense populated so the constrain potential remain low. This has a direct impact in economical assessment for further evaluation of those areas. Analysing the scenario that after 50 years the deposits in Siboc will be exhausted and parallel to that reclamation of land in old mines is realized than this two lignite fields (Dukagjini and Drenica) offer great possibilities to overtake the energy production based in domestic lignite for the period beyond. This has the advantage because that part mostly is green field and not very dense populated so the constrain potential remain low. This has a direct impact in economical assessment for further evaluation of those areas.

8.6. Drenica Basin

Drenica basin lies between the basin of Kosovo to the east and west basin Dukagjin with a total area of 3.97 km^2. Drenica Basin is characterized in two areas: Area of Skenderaj and areas north and south Gllabari near to the Drenas town. Infrastructure and communications links with other centres are good. National and regional roads pas through the area of lignite fields (Drenas Skenderaj road, road Pristina-Mitrovica-Peja and Podgorica, while rail connection between Pristina and Peja das not limit the exploitation of fuel because passes along the side of lignite fields).

Quality of Lignite - Based on geological data presented in elaborate geological reserves of lignite for this basin, the maximum value of the lignite quality is in southern-central part 9213 kj/kg and the average 7117 to 7955 KJ/kg, while the minimum value the quality of lignite is 4188 KJ / kg, in the eastern part. From 44 drilling conducted from 1965-1980 with total length 1790m, 42 drills have provided elements for the possibility of defining the border of deposit and calculating the reserves. The thickness of the overburden on average is 35 m, while average thickness of the layer of lignite is 23.02 m.

Drenica Lignite Basin	Data
Total Area [km^2]	18
Geological Lignite Resources [Mt]	500
Mineable Resources [Mt]	270
Estimated Average Geological Stripping Ratio [m/m]	1,7/1
Average Calorific Value [kJ/kg]	7117 -7955
Corresponding Size of Power Plant [MW]	300-500
Inhabitants/ Number of affected inhabitants	6080/4970/(82%)
Regional dispersion of lignite resources from actual mining-distance[m]	38500
Water availability	No/yes
Economical Impact	Yes
Extraterritorial jurisdictions of communities{Ha]	No
Highway and railway(m)	0
Regional and local road (m)	27450
Distance of lignite from PP (m)	32500
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	30500
Natural protected areas(Ha)	1056

Table 8-13: Data for Drenica lignite basin

Constrains and Criteria for lignite reserve valorisation are the same that were used for the Kosovo and Dukagjini basin. According to calculations made so far, geological reserves in the basin of Drenica were: approximately 500 Mt and of these, as mineable reserves are estimated balances about 270. Mt.

Drenica Basin	Inhabitants	Number of affected inhabitants	Affected inhabitants[%]
Bletar	1095	1095	100
Cikatove e vjeter	1320	1125	85
Qendrese	3665	2750	75
Total	6080	4970	82

Table 8-14: Settlements in Drenica Basin

On the other hand for the same basin overburden measures are: 269.5 Mm^3, where the stripping ratio overburden/lignite is approximately 0.76/1. Positive fact is that in this area there is no extraterritorial jurisdiction area and as well this basin offers dispersion of future mining activities in order to support the economical development in on of the poorest areas in Kosovo. Bellower tables with data for inhabitants, nature protected areas, infrastructure, quality and quantity of lignite in Drenica Basin.

8.7. Basin of Babush and Other Lignite Fields

Being associated with data from previous geological research, there are indications that the lignite can be present in more locations through Kosovo. One of the potential sites is Basin of Babush and indications that the region of Dardana-Karaqevë is rich on lignite have to be proved through investigation. Also there are shown indications in the territory of the Municipality of Ferizaj and in the municipality of Besiana but those areas still are not well explored. In the future should be planned and implemented new geological research. At the moment when this study is working, these perspective areas are not seen from particular interest to enter into any priority in the long term strategy development for the mining and energy sector. Thereof those possible fields are not evaluated in final ranking.

Chapter IX

9. OWERVIEW OF POSIBLE FURTHER MINING EXPLORATION –ANALYSIS AND ALTERNATIVES

This chapter refers to the identification and allocation of potential future lignite mining areas within the Kosova lignite basins. Not all of lignite deposits are qualified to be protected for the purposes of mining investments; therefore it is necessary to establish their potential attractiveness, which will show the order of their development in long term view. Establishment of a ranking of lignite deposits according to fixed estimation criteria is needed for programming the development of a given branch of mining. Before making a decision on the development of mineral deposits, there is a need to choose deposits, which are available and which are characterized by the best technical and economical affectivity of extraction. The problem of lignite deposits development is especially visible when the amount of recognized mineral resources is numerous. As a result, the search for a different method, which would allow for a complex valorization of mineral deposits and the establishment their ranking, was necessary. This is an attempt that is made to apply analysis and find alternatives, which considers both the numerical and non-numerical factors that characterize lignite deposits. The usefulness of this methodology is verified on the basis of lignite deposits' valorization. Some very valuable features of the method presented in this study include:

- Development of the point method through the specification and introduction of new factors (criteria and constrains),

- Application of a so called positive versus negative point evaluation for the deposits' classification,

- Implementation of economic factors in a simplified form, recognizing difficulties by constrains like extraterritorial jurisdiction areas that impact largely in some lignite fields.

Differently to the commonly applied chronology of action for the selection of the best solution, the selection of the lignite resources was made on the basis of an initial evaluation of the profitability of their development taking into account the deposit value parameter. The characteristics of quantitative and qualitative features of the mineral deposits, as well as geological-mining and geographical-economic criteria adopted for the evaluation were the basis for the economic valorization of the lignite deposits. In the next stages, the valorization of the lignite deposits was made using the point method and other impact factors. The possible potential constrains and conflicts between mineral extraction and the environment, infrastructure, possible air pollution was also established as part of the valorization. Social valorization and natural protected areas are analyzed as well in order to have clear view of constrains and strength by the lignite deposit valorization. At the first stage of the economic analysis in short term are analyzed fields that are actually active and in medium and long term view 8 lignite field deposits are selected as potentially

profitable for extraction. As a result of the above, not all deposits met all criteria at the same time. The result of such analysis summarises the identification of future lignite resources and the following scope has been undertaken:

1. Identification of potential future mining areas within the Kosova lignite basin, the Dukagjini lignite basin and Drenica lignite basin.

2. Visualization of the identified mining areas on maps along with settlements, regional dispersion, quality, quantity, and major existing infrastructure nearby the mining activities. Description of the identified mining areas and their boundaries including information on lignite resources, total area, quality, quantity, stripping ratios, calorific values, possible power plant capacities to be supplied, and other relevant information on required resettlements, relocation of infrastructure, extraterritoriality etc. as far as information on these subjects is available.

9.1. Further Lignite Exploration Alternatives

In this regard, different kinds of factors that influence the attractiveness of lignite deposits were analyzed as listed above and a working scenario for lignite development alternatives is derived. The present analysis attempt a modelling exercise that would show how lignite supply are driven by different variables as mentioned in previous chapters. These variables are discussed qualitatively and quantitatively, along with certain distinctive aspects of the developing Kosovo market for solid fossil fuels. The development scenario is determined by the constrain potentials in the areas, taking into account mining technical aspects, lignite quality seem thickness and other preconditions various alternatives for various fields are taken into account. As a rule, for each of the area two planning alternatives are analysed. The first alternative is aimed by planning to explore the maximal exploitation of the deposits with regard to the optimal field shape that makes technically possible the lignite excavation. In this regard only major constrain areas, such geological-mining, economic, environmental, spatial and social factors can have impact and exclude these areas from the field. [21].

The second alternative takes into account major constrains within the deposits. Here possible mining field was determined from: specific resettlement in inhabitant per Mt of lignite, specific claim of protective areas in square meter per Mt of lignite, specific claim of infrastructure equipment (streets, railways), fuel quality and quantity with possible PP size, water availability, air quality with respect to allowable, extraterritorial jurisdictions of communities, distance of lignite deposits from PP .and regional dispersion of lignite resources. For later-specific constrain analysis, the knowledge of the recoverable fuel amount in the various fields of mining lignite is needed. For this reason, for each of the planning options are volumes and demand data for lignite taken into account. Mainly the boundaries of potential fields are existing there and this make easy to calculate other potential data and constrains present there. However it is chosen the way to establish at least two alternatives per each lignite field. For a better understanding of the constrains in the specific areas it is supposed to be considered that in determining the future mining fields, only

constrain categories mentioned above(specific resettlement in inhabitant per Mt of lignite; specific claim of protective areas in square meter per Mt of lignite, specific claim of infrastructure equipment (streets, railways), fuel quality and quantity with possible PP size , water availability, air quality with respect to allowable, extraterritorial jurisdictions of communities, distance of lignite deposits from PP, regional dispersion of lignite resources) have been considered. The other limitation was not considered because of minor significance. The first possible field boundaries alternative is marked with red colour , this alternative das not deal with specific constraints but takes in account general remarks related to the geological, mining, spatial, environmental and economic factors affecting the field. The second alternative is represented with black and takes into consideration all specific limitations and constrains as mention above. On the basis of the analytical decision model, than is prepared the assessment of the relative importance of elements located on particular levels of the lignite field valorization hierarchy.

9.2. Description and Analysis of Potential Lignite Fields

9.2.1. Siboc Field

Because of the small numerous constrains that are occurring the field Siboc, this field offers very favourable conditions for excavation of lignite. For the field, two planning alternatives have been analyzed.

The first alternative (red line) includes maximal possible exploitation of lignite without having considered the limitations and impact constraints. However this does not present the best solution because increase costs and affects directly a large number of inhabitants. The second alternative (black line) is based essentially on the maximum economical benefit of field cutting, however minimizing the constraints from the mining field. A number of relocation is necessary in this alternative as well but there is avoided relocation of different localities. The distance to the villages is defined according to the Kosovo mining law and this has to be considered. There are as well impacts from extraterritorial jurisdiction in negative sense. Total area of the basin is mainly agricultural land, however includes lot of other conflicts and constrains that influences final position of the field in future activities.

Agricultural potential areas – Agriculture, according to data presented is the dominating land use in the area. Agricultural lands cover 55% or 8080 ha of the territory, and are mostly used for cultivating wheat and corn, but also vegetables in limited areas. Forests in the mentioned area take a territory of 2.325 ha or 16% of its total area. In the western area, there are low forests made of a belt of xerotermophile and mesothermophile oaks and other types such as: *Querrcus Frainetto*, *Qurqus Cerris*, *Carpinus Orientalis*, *Fagus Moesiaca*. The south-western area of the zone is covered and characterized by a forest area established by forestation, mainly with pine - *Pinus Silvestris* and black pine– *Pinus Negra*. These are mainly low and degraded forests.

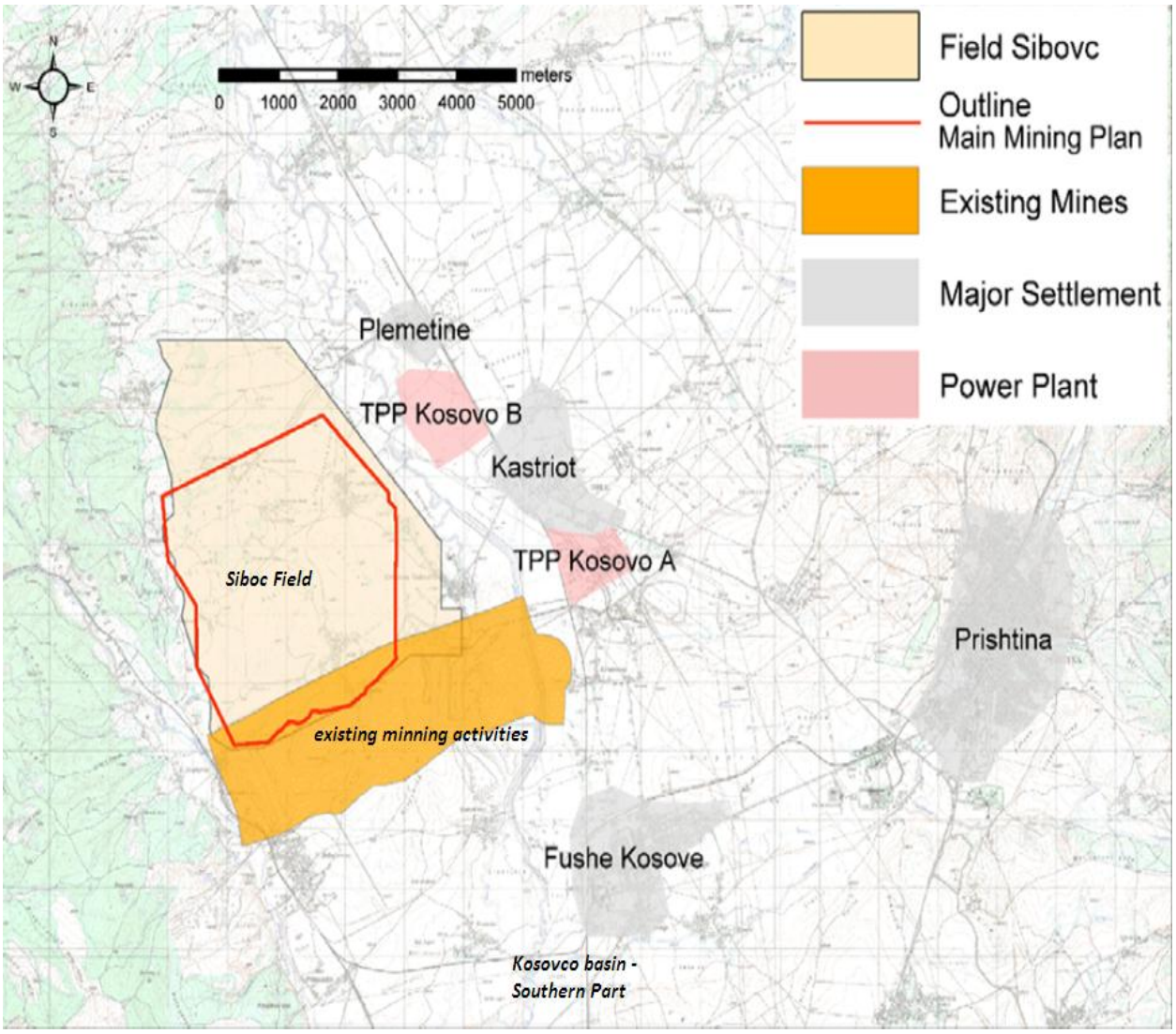


Figure 9-1: Alternative exploration and location Field Siboc [34]

Around 8% of the total area or 1.320 ha are areas covered by these external overburden dumps. Industrial areas like facilities for electricity generation – Kosovo A and Kosovo B TPP are the only sites of industrial importance in the area. Also, within these sites, close to the Kosovo A Plant, there are Gasification and Fertilizer Plants, which have been out of operation for the last two decades. Today, they represent a large environmental problem, due to contamination mainly of phenols and other substances. All these industrial sites, with all facilities, take only 1%, or lignite area.

Other constrain potentials are still within the mining field, like infrastructure facilities, such as the national, regional roads and railway line through the mining field variation that are taken into account. In the south-eastern area of a mining field exists development plan for the new highway that is not approved until now by the National Assembly therefore is not considered as constrain potential

Siboc Field	Data	Valorisation Values-Points
Total Area [km^2]	19.7	-1.97
Geological Lignite Resources [Mt]	990	5.03
Mineable Resources [Mt]	830	5.28
Stripping Ratio	0.9:1	5.5
Average Calorific Value[Kj/Kg]	8.3	4
Corresponding Size of TPP [MW]	2,000 – 2,500	7
Inhabitants/ Number of affected inhabitants	84333/7739/ (92%)	-8.5
Regional dispersion of lignite resources from actual mining-Distance[m]	No	0
Water availability	Yes	3
Economical Impact	250	12.5
Extraterritorial jurisdictions {Ha]	65	-9.75
Highway(m)	0	0
Regional and local road (m)	15567	-1.56
Distance of lignite from PP (m)	750	-0.75
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	250	-0.25
Natural protected areas(Ha)	520	-5.2

Table 9-1: Valorisation data for Siboc field

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9.2.2. South Field

Geologically for South Field 65 borehole data (litho logical descriptions), were available. A total of 27,731.7 m were drilled by these boreholes. The deposits are characterized by an at least 60 to 80 m thick lignite seam which is covered an overburden layer of 100 to 150 m. The stripping ratio overburden to lignite is about 2/1. Compared with the Siboc field the overburden volume doubles. In general there is the tendency of the overburden lignite ratio to change to the worse into Southern direction.

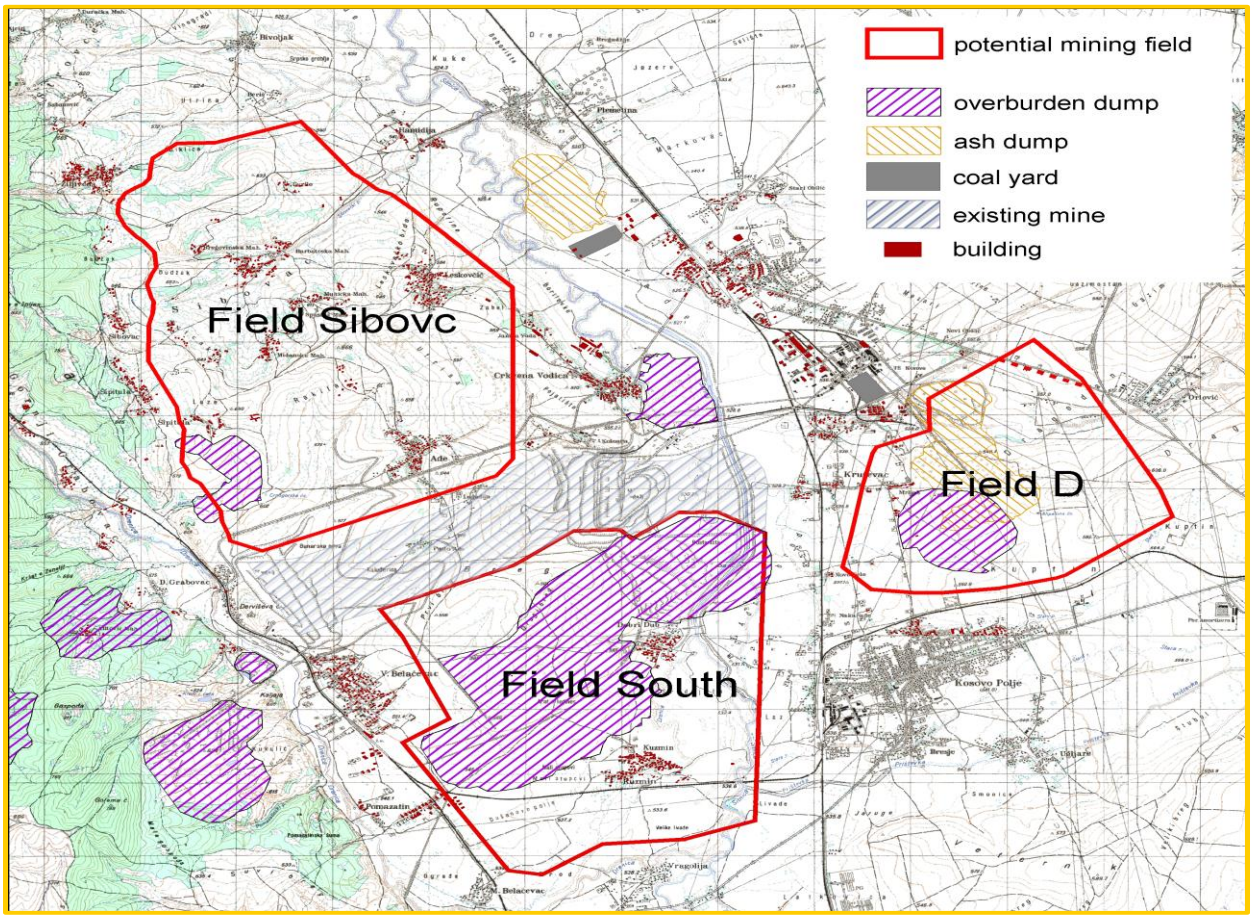


Figure 9-2: Alternative exploration and location -South field, Siboc and Field D

In addition to the geological overburden, large amounts of dump material will change this ratio further to the worse. These dumps comprise a total volume of 90 to 110 Mm³ (slope angle ca. 6°) of an entire area of 5.5 km² and an average dumping height of 20 to 30 m. The dump soil is very difficult to excavate. Besides the problems in the excavation and transportation process, there are considerable problems of static stability for the slopes to be built. Gravel shall be available to stabilize particularly the working levels although this material is not available in the mines. The following parameters depend on the chosen field boundary for two possible alternatives of secure supply in middle term (as table below shows). Even if there is not very populated area, in any case, for both alternatives, resettlement of the villages of Lismir and Kuzmin are

required. In alternative the river Sitnica has to be relocated additionally. The Sitnica River is located at the eastern rim of Mirash East Pit. Its riverbed is running at only few meters distance along the mining rim. To manage this situation a bypass diversion of about 1500 m length at a gradient of 0.86‰ should be constructed and completed.

Valorization factors-South Field	Datas	Valorisation Values-Points
Total Area [km^2]	8	-0.8
Geological Lignite Resources [Mt]	537	6.7
Mineable Resources [Mt]	370	5.78
Stripping Ratio	2.8:1	1.35
Average Calorific Value]	8,000-8,300	4
Corresponding Size of TPP [MW]	1,000	3.3
Inhabitants/ Number of affected inhabitants	2512/2265	-4.68
Regional dispersion of lignite resources from actual mining-distance[m]	No	0
Water availability	Yes	3
Economical Impact	180	0.9
Extraterritorial jurisdictions {Ha]	15	-2.25
Highway(m)	0	0
Regional and local road (m)	3567	-3.567
Distance of lignite from PP (m)	1250	-1.25
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	750	-0.75
Natural protected areas(Ha)	150	-1.5

Table 9-2: Valorisation data for South field

This bypass will run approximately 400 m east of the existing riverbed. It would have been much better to immediately start with the larger diversion design by which the costs will be reduced and immediate access to easily recoverable lignite reserves of nearly 30 Mt could have been guaranteed. Sitnica River will be diverted through a 3 km long channel 100m to 600m east of the present river course. There are no other buildings which could have a relevant influence. Positive is the water supply infrastructure and direct connection to the existing mining fields.

9.2.3 Field D

The creation of the cutting options for the deposit in Field D was very easy due to the very regular shape of the deposit.

Field-D	Data	Valorisation Values-Points
Total Area [km^2]	7.8 km^2	-0.78
Geological Lignite Resources [Mt]	395	5.06
Mineable Resources [Mt]	280 (71%)	4.49
Stripping Ratio	0.9:1	5.5
Average Calorific Value[Kj/Kg]	7,800	2.5
Corresponding Size of TPP [MW]	600	2
Inhabitants/ Number of affected inhabitants	3970/3970/ (100%)	-1.01
Regional dispersion of lignite resources from actual mining-Distance[m]	No	0
Water availability	Yes	3
Economical Impact	25	1.25
Extraterritorial jurisdictions {Ha]	10	-1.15
Highway(m)	0	0
Regional and local road (m)	5567	-5.57
Distance of lignite from PP (m)	850	-0.85
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	950	-0.95
Natural protected areas(Ha)	255	-2.5

Table 9-3: Valorisation data for South field

The maximal alternative is based on an industrial scale of lignite field exploitation. The second version was planned with a minimum of constrain, however, is inevitable in this alternative, the resettlement of the village Dardhishte. Field D lies in directly beside the power plant TPP Kosovo A and ca. 5.5 km away (straight line) from the power plant Kosovo B. In the West it borders the village of Dardhishte and in the South it boundaries with the small town Fushe Kosove including infrastructure like road and railway line, whereas the seam thickness thins out to below the economic limit into East/North-East direction and in parallel the lignite quality changes to the worth.(Figure 9-2). A minimum distance between the lignite field boundaries and villages was taken into consideration. Already in the past lignite was extracted on the territory of field B. The major part was mined in underground mines. Furthermore, opening-up masses from the Mirash mine were deposited on this area. There are only few houses on lignite Field D. Below are data that explain all constrains and show as well strength sides of the field.

9.2.4. Kosovo Basin Southern Part

For the Kosovo Basin –Southern part both alternatives are analyzed and planned in regard of possible mining areas for the future.The results of this planning and the principles in the form of the identified areas of constrain are shown in Figure below. The maximal alternative of the field considered in itself the towns Fushe Kosovo and Lipjan. In the north it bordered with existing mine activities from Mirash and Bardh mine. The deposit in the southern part of the Kosovo lignite basin includes several divided areas however with large number of constrain potentials from all possible sources.Area F- is located directly south of South Field and has a size of about 18 km². Within about 45 % of Area F the geological stripping ratio is better than 2/1 (m/m). In the southwest corner of Area F, however, the overburden thickness varies between 150 and 200 m, whereas the seam thickness amounts up to 60 m, only, thus limiting the economic feasibility of opencast mining.. Area F is characterized by dense population within a number of villages and the junction of the rivers Sitnica, Drenica, Pritevka and Gracanka in the North. This situation reduces the mineable area to approximately 28 %, or an assumed surface of 5.4 km². As a result of the geological conditions and the constraints at the surface, mineable resources are limited to some 430 Mt within Area F.

Area G - is located south of the river Pritevka. In the East the area is limited by the boundary of the deposit. In the West and in the South railway tracks have been selected as borders. The total area amounts to approximately 22 km². The area is separated into a northern part by the river Gracanka. Particularly in the northern part of Area G the conditions regarding stripping ratio as well as surface obstacles would be advantageous for an opencast mine. The stripping ratio is less than 1.5/1 (m/m) in most part of the zone. The overburden thickness does not exceed 100 m. The population within Area G is concentrated within a number of villages along the river Gracanka. If it is assumed that these settlements as well as the river would not be relocated, the northern part of Area G still is of sufficient size for the operation of an opencast mine. It is recommended to reserve this area for a future opencast mine. The mineable lignite resources within Area G amount to some 720 Mt.

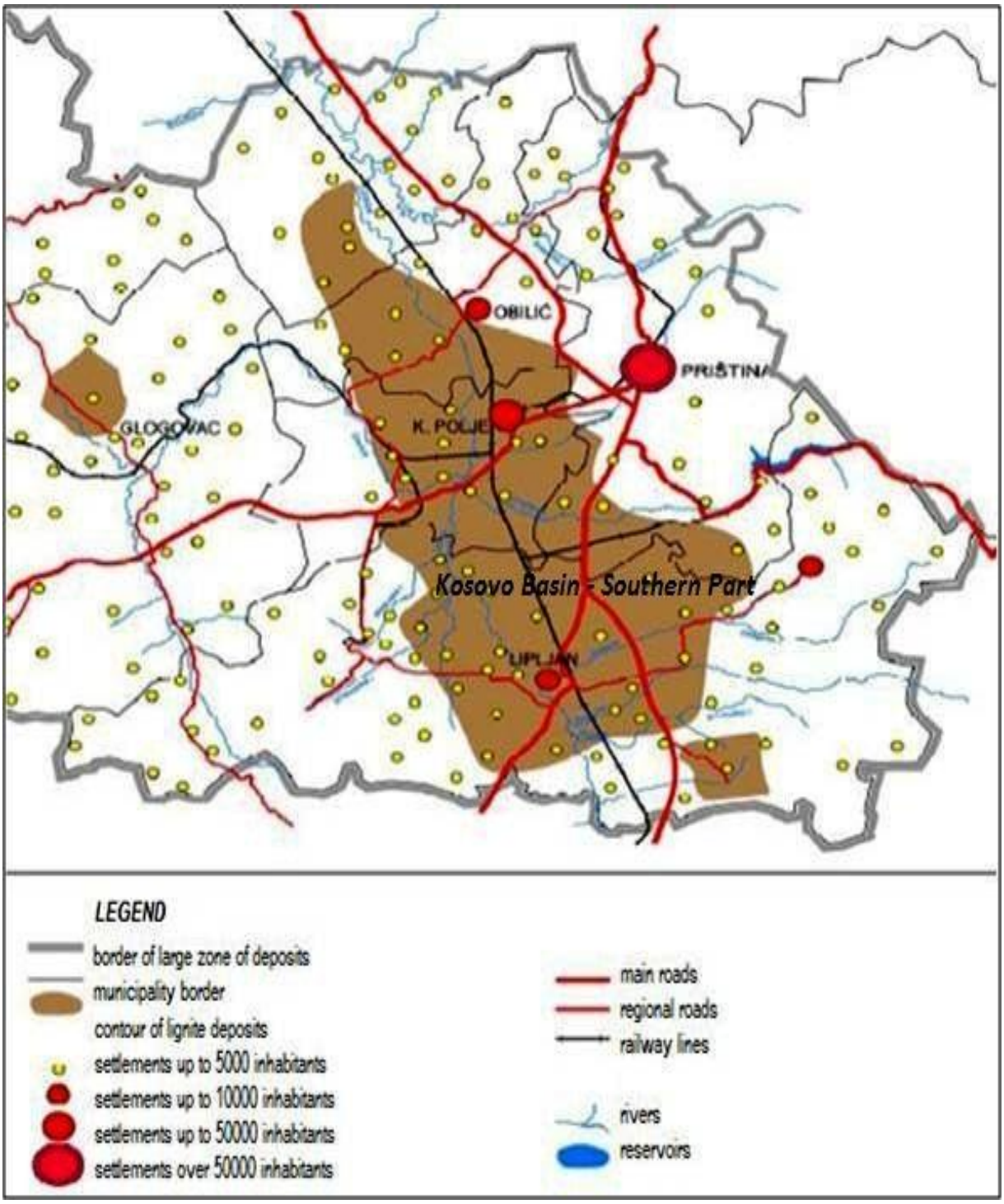


Figure 9-3: Alternative exploitation and location of the interesting areas-Kosovo basin southern part

Area H - is located south of Area G. In the West the area is limited by the boundary of the deposit. In the East railway tracks have been selected as borders. In the South the borders are given by an imaginary line in extension of the river Janjevka, starting at its junction with the river Sitnica. The total area amounts to

about 24 km². The area is separated into an eastern and a western part by the river Sitnica. Only some 19 % of Area H provides stripping ratios of less than 2/1 (m/m). These parts are located east of the river Sitnica. Here the overburden thickness is 70 m in average and the lignite seam thickness amounts to 50 m. The population within Area H is concentrated within a number of villages west of the river Sitnica. For the above reasons the mineable lignite resources within Area H decreases to approximately 170 Mt only.

Area I - is located south of Area G and west of Area H. In the east, the area is limited by the boundary of the deposit. In the south the area is limited by the river Janjevka. The total area amounts to some 22 km². Some 73 % of Area I provide stripping ratios better than 2/1 (m/m). The average geological stripping ratio is 1.2/1 (m/m), only.The thickness of overburden varies between a few meters up to 100 m. Within the major part of Area I, however, the overburden thickness is below 50 m. The population within Area I is low and major surface obstacles are not present. Summarizing the above conditions for opencast mining within Area I can be described as favourable. An opencast mine could be opened up as a standalone operation or in extension of a mine within the southern part of area G. The mineable lignite resources within Area I are estimated with some 430 Mt. A summary of the estimated area, resources and power plant capacity is shown in the table above. Area J- It is located east of Area I, limited in the east and southeast by the boundary of the deposit. In the south the area is limited by the river Janjevka.

The total area amounts to some 19 km². Only approximately 25 % of Area J provide stripping ratios better than 2:1 (m: m). Here the average geological stripping ratio is 1:1 (m: m), only. The thickness of overburden varies between a few meters up to 50 m. The thickness of the lignite seam is 20 – 40 m. The population within the part of Area J is low and major surface obstacles are not present. This is considered favourable for mining. In summary, the conditions for opencast mining within Area J can be described as favourable. However, the mineable lignite resources are limited to an estimated 115 Mt only. A summary of the estimated area is given in the following table.

Area K - covers the southern corner of the Kosovo Basin. Its limits are defined by the geological border of the deposit. In the North the area is limited by the river Janjevka. This area is not densely populated and therefore has advantages cause there are not necessary any resettlements. Its amounts is approximately 11 km² but only approximately 25 % of Area J provide stripping ratios better than 2:1 (m: m). The thickness of overburden is not very favourable and varies between a few meters up to 50 m. The thickness of the lignite seam is 30 – 45 m. This is considered favourable for mining. In summary, the conditions for opencast mining within this Area can be described as favourable. The total area covers approximately 33 km². Only some 9 % of Area K provides stripping ratios better than 2/1 (m/m). The thickness of overburden varies between a few meters up to 50 m. The thickness of the lignite seam is 20 – 40 m. Area K is densely populated especially in the mining wise rather interesting parts. Thus, the mineable lignite resources are limited to some 70 Mt, only. Within the mining field variations of the field go further in the versions 1 and 2 constrains regarding the construction area at the airport, to the east of the town of Lipjan. Additional facilities of the airfield flow of the river and the long part of Highway and regional roads within the mining field alternatives 1 and 2 makes in both cases very unfavourable this part of Kosovo Lignite basin.

Kosovo Basin Southern Part	Data	Valorisation Values-Points
Total Area [km^2]	139	-13.9
Geological Lignite Resources [Mt]	2600	1.8
Mineable Resources [Mt]	1800	1.2
Stripping Ratio -Average	1.34/1	3.75
Average Calorific Value (kj/kg)	7600	2
Corresponding Size of TPP [MW]	4180	13
Inhabitants/ Number of affected inhabitants and [%]	66629/63324/ (95%)	-2.56
Regional dispersion of lignite resources from actual mining-distance[m]	3500	-3.5
Water availability	no	0
Economical Impact	1500	75
Extraterritorial jurisdictions of communities{Ha]	710	-10.65
Highway and railway(m)	54000+3600	-180
Regional and local road (m)	38000	-38
Distance of lignite from PP (m)	18500	-18.5
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	16500	-16.5
Natural protected areas(Ha)	29020	-29.02

Table 9-4: Valorisation data about Kosovo basin southern part

Uneven regional development as well as the trend of increasing concentration of the population, activities, investments, and construction of settlements, economic, infrastructure, public and other facilities in Prishtina and its surroundings plays a role in estimation about field boundaries in southern part of Kosovo lignite basin. High population density and socio-economic characteristics of the population living in the Kosovo southern part of lignite area, and especially above the Kosovo lignite deposit, substantially limit the

use of lignite for electricity production. In addition to the clashing utilization of the two main natural resources in this area – lignite and agricultural land – with exploitation of one limiting the use of the other, there is yet another limiting factor – the population. Far from other fields, here is expressed also the negative impact of extraterritorial jurisdiction of parts of the land that minimize the possibility for future use of lignite from this area. Above are presented all data and valorisation points of the field.

9.2.5. Dukagjini Basin

Dukagjini Basin-Area 1	Data	Valorization Values-Points
Total Area [km^2]	49	-4.9
Geological Lignite Resources [Mt]	240	0.49
Mineable Resources [Mt]	170 (~70%)	0.47
Estimated Average Geological Stripping Ratio [m/m]	1.7/1	1.85
Average Calorific Value [KJ/Kg]	8400	4.5
Corresponding Size of Power Plant [MW]	450	1.5
Inhabitants/ Number of affected inhabitants and [%]	955	-5.6
Regional dispersion of lignite resources from actual mining-Distance[m]	88500	8.85
Water availability	yes	3
Economical Impact	80	4
Extraterritorial jurisdictions of communities{Ha]	110	-16.5
Highway and railway(m)	0	0
Regional and local road (m)	12300	-12.3
Distance of lignite from PP (m)	500	-0.5
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	500	-0.5
Natural protected areas(Ha)	478	4.78

Table 9-5: Valorisation data about Dukagjini basin-Area1

Dukagjini Basin-Area 2	Data	Valorization Values-Points
Total Area [km^2]	46	-4.6
Geological Lignite Resources [Mt]	440	0.95
Mineable Resources [Mt]	310	0.67
Estimated Average Geological Stripping Ratio [m/m]	3.1/1	1.6
Average Calorific Value [kJ/kg]	8700	6
Corresponding Size of Power Plant [MW]	840	2.8
Inhabitants/ Number of affected inhabitants and [%]	1435	-4.62
Regional dispersion of lignite resources from actual mining-distance[m]	85000	8.5
Water availability	yes	3
Economical Impact	70	3.5
Extraterritorial jurisdictions of communities{Ha]	110	-16.5
Highway and railway(m)	0+13800	-2.76
Regional and local road (m)	27500	-2.75
Distance of lignite from PP (m)	950	-0.95
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	9500	0.95
Natural protected areas(Ha)	178	-1.78

Table 9-6: Valorisation data about Dukagjini Basin-Area2

The Dukagjini Lignite Basin is the second largest lignite deposit in Kosovo. It is located in the western part of Kosovo and covers an area of 95 km² (Figure 9-5). Here the seams show a general dip of some 2° - 8° in eastern direction. From the information provided by MEM and field exploration it can be concluded that the Dukagjini Basin is a multi-seam deposit. Further information about the thickness of the individual seams and interburden are not available. It is indicated, however, that of a 40 m thick lignite bearing zone

about 30 m are exploitable. Therefore, it is assumed that thickness of individual interburden layers is approximately 10 m.

For the field Dukagjini due to numerous constrains and very irregular form of possible mining areas were very problematical to shape the boundaries for whole basin so it is decided to set boundaries just for most important areas- Area 1 and Area 2 like it is shown in the figure. By cutting only the few kilometre of national and regional road sections of are in constrain. Besides the considered constrains that occur in the mining field alternative created further constrain appears because of the other surface uses, especially agricultural use of land. The version for the field Dukagjini is in the northern area in constrain with rail road I. Also within the mining field limits are as well there because of overburden/lignite ratio and due to the green field that das not posses any infrastructure, regarding to the mining activities. Below are data and valorisation points for the Dukagjini Basin in both alternative areas.

9.2.6. Drenica Basin

Drenica basin is located in centre of Kosovo about 35 km from capitol Prishtina between municipalities of Skenderaj and Drenas. It is not very well explored basin which area is approximately ¼ of Dukagjini lignite basin. Seam lignite thickness varies from 7-27 m with an average of 20 m. According to the geological data there are located some 500 Mt of Lignite. Drenica basin is divided in two lignite fields Skenderaj lignite field and Drenasi lignite field (Figure 9-6).

The lignite basin-Drenica Basin, lies in the eastern part of the municipality of Skenderaj and goes in direction of the Drenasi municipality including in it two potential mining areas. Geographically lies between the two main lignite basins, Kosovo and Dukagjini Lignite basins and comprises an area of 3.97 km^2. This part of Kosovo is covered with 6 mostly scattered settlements. These settlements are within the territory of Skenderaj and Drenas municipality. Unfortunately there are just few data about lignite quality and quantity so, taking into account these and other specifications for the use of lignite from the basin of Drenica, we recommend that basin of Drenica area has to be announced the general area of interest.

There is possible constrain potentials regarding regional and national roads. Meanwhile the large number of inhabitants has to be resettled in order to exploit those lignite reserves. One other unfavourable factor is that overburden / lignite ration is much worse than by Kosovo Basin lignite so this makes this field not very attractive for the next future.

Drenica basin is third main lignite field that in long term offers good possibility to spread the energy production in central part of Kosovo and this field need to be more explored in the future.

During researches there are analysed different possibilities in this area and it dominates the opinion that it is needed more intensive exploration work to estimate real value of the fuel in long term. Anyway there are

no doubts that this field posses great possibilities to support the energy capacities in long term period. Above in the table are data and valorisation points for the Drenica lignite basin.

Drenica Lignite Basin	Data	Valorization Values-Points
Total Area [km^2]	18	-1.8
Geological Lignite Resources [Mt]	500	2.7
Mineable Resources [Mt]	270	1.5
Estimated Average Geological Stripping Ratio [m/m]	1,7/1	2.94
Average Calorific Value [kJ/kg]	7955	2
Corresponding Size of Power Plant [MW]	300-500	1.7
Inhabitants/ Number of affected inhabitants and [%]	4970	-18.4
Regional dispersion of lignite resources from actual mining-distance[m]	38500	3.85
Water availability	yes	3
Economical Impact	120	6
Extraterritorial jurisdictions of communities{Ha]	No	0
Highway and railway(m)	0	5
Regional and local road (m)	7450	-7.45
Distance of lignite from PP (m)	2500	-2.5
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	2500	-2.5
Natural protected areas(Ha)	56	-0.56

Table 9-7: Valorisation data about Drenica Basin

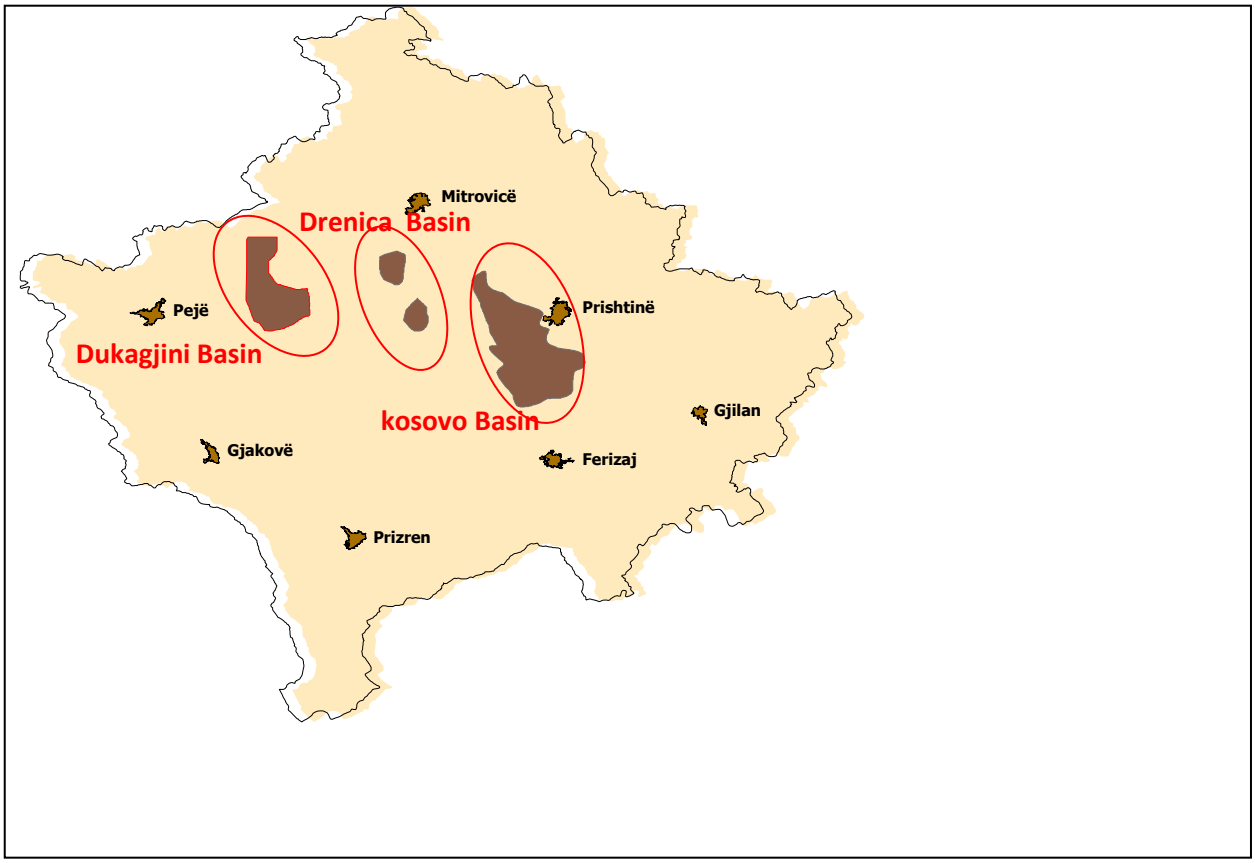


Figure 9-5: Location of lignite areas-Kosovo, Dukagjini and Drenica Basin

9.3. Supply Situation Assessment

Strategic concepts in the energy sector are based on long-term prognoses, while long-term prognoses in other fields, especially economy and social development, are considered unreliable. The work has dealt with this discord by using different levels of detailed forecasting for different time periods. Thereby more detailed and reliable solutions were proposed for shorter horizons, while longer-term proposals offer only tentative solutions, are often limited to the objectives and main premises, and sometimes presented in different alternatives. It is assumed that these long-term prognoses will be re-examined in the subsequent cycles of research and planning. We believe that changes in demographic developments, competencies for decision-making on development in general and energy development in particular, do not substantially impair the relevance of research findings and topicality of proposed propositions, which is yet another reason why they should be presented to the professional and academic public.

The subject of research in elaborating strategic management of lignite fields is the organization; arrangement and use of those domestic important resources which is influenced by the limitations in form of constrain potentials for further exploitation that will serve as base energy resource of the country. Future

development in Kosovo, in long terms, is built upon regional integration, based on social, economic and territorial cohesion and cross-border cooperation. Kosovo will base its future economic development on the energy development through electricity generation by using its natural resources. Under the same MGS hypothesis, the maximum capacity demand is expected to reach a level of close to 1,400 MW in mid term developments by 2020. In the high growth scenario (HGS), on the other hand, the total electricity demand is expected to reach almost 1,900 MW in the same year. This shows that lignite supply has to be strategically developed in order to meet the demand. This means that an adequate supply of electricity represents a basic requirement for the economic development of the country. It is clear from all the work done in Kosovo over the years that the potential for power generation from lignite remains far and away the major asset. Moreover, the importance of the lignite fuel and energy sector for the future development of Kosovo should be seen from two aspects:

a) At the function of the establishment of stable energy infrastructure for a dynamic economic and social development.

b) The importance of considerable primary energy resources, in particular lignite and its rational exploitation, in the context of the overall development strategy of Kosovo. This has the potential to produce a multiplier effect on business investment, and on job prospects.

The participation of Kosovo in the Regional Electrical Energy Market in South Eastern Europe poses huge challenges in terms of adequate development of the energy sector, but at the same time offers important opportunities for an export market. The potential sales shown in the table below refer to what is called the "first tier of markets", that is to those neighbouring countries with direct grid connection and politically acceptable circumstances. In principle, additional markets could correspond to more remote countries with more complicated grid access (e.g. Bulgaria) or to countries outside the area (e.g. Italy) that are net importers of electricy

Country	Energy demand in 2020(TWh)	Output level(MW)
Macedonia	2.5	200-300
Montenegro	2.5	200-300
Albania (base and peak load)	2.4-4.8	500-800
Kosovo	3.7	500
total	11.1-13.5	1400-1800

Table 9-8: Total possible utility sales from future new lignite based generation plants in Kosovo

Based on those figures it is clear that future developments in the sector would support the further assessment of the lignite deposits of Kosovo. Analogous to the above explained procedures the

approaches to constrain analysis are also important factor in the preparation of the ranking list with regard to the lignite production stocks in order to ensure the support of energy activities of the country. Development orientation and advancement paces in the new lignite mines will depend on the constrain classes, favoured estimates and selections, as per scenarios mentioned above for duration and location of development, on unit capacity and generation technology for the new plant.

Chapter X

10. LIGNITE RESOURCE VALORISATION AND PROSPECTIVE CLASIFICATION

The valorisation of mineral deposits is necessary in order to specify the requirements concerning their protection. Not all mineral deposits should take priority over other elements of the environment in terms of their protection. Therefore estimation is carried out of the value of particular lignite deposits in order to establish their meaning for the economy, taking geological-mining, environmental, social and spatial aspects into account in the case of mineral deposits' development. As well there are other important factors influencing the mineral deposits attractiveness like social acceptance of such developments. The legal regulations in Kosovo make it possible for the community to express its comments and remarks concerning the planned investments. Since investments concerning mine building are connected with significant environmental conversion, they usually do not receive social acceptance, specifically not in small country like Kosovo where the density of population is among the highest in the Europe. In Kosovo case according to state regulation there are foreseen "extra territories" that belong to the religion institutions (Orthodox Church) and they have the possibility to decide in their own about the piece of land. That is why they influence as well the future decisions in the lignite development.Based on the previous sections regarding fundamentals of the identified areas and constrain potential of the possible access to the land, in the following analysis the evaluation of the data and evaluation of future lignite fields can be made. The aim here is the valorisation and ranking of mineral deposits against limited values to their estimation of geological-mining, environmental and spatial factors whereas the sum of the points established in the point procedure acted as a tool for establishing the position of given deposits. The deposits which received the highest score were recognized as the most useful for development. A hierarchical method based on total point analysis, attempts to consider complex analysis of the effects, which could be caused after the analytical research of specific constrains and factors as will be shown below. The aim is to develop a list of potentially suitable mining areas in the form of a possible developing guide that allows a decision on the future supply of energy in Kosovo based on domestic energy sources.

10.1. Risk Context and Strength Evaluation– Constrains, Limits and Possibilities

Previously the possible constrain factors and areas were identified within the lignite deposits o in relation to the settlements-human beings, specific claim of infrastructure equipment (streets, railways), fuel quality

and quantity with possible PP size, water availability, air quality with respect to allowable, extraterritorial jurisdictions of communities, distance of lignite deposits from PP, regional dispersion of lignite resources and on other land use possibility. This analysis set up bases in direction to the definition of future mining alternatives. Besides the human settlement constrain areas, other limitations and strengths are evaluated, especially mining technical specifications the quality and power plant size taken into account. In addition, calculations could be made to the recoverable amount of lignite on the basis of information provided that is used during the study. The investigations and analysis for the potential constrain or future mining activities include valorisation factors as below:

Total Deposit Area [km2],

Geological Lignite Resources [Mt],

Mineable Resources [Mt],

Stripping Ratio, Overburden/Lignite [m^3/Mt],

Average Calorific Value [Kj/Kg],

Corresponding Size of TPP [MW],

Inhabitants/ Number of affected inhabitants per Mt of lignite

Regional dispersion of lignite resources from actual mining-distance[m],

Water availability for PP and mining activities,

Economical Impact,

Extraterritorial jurisdictions of communities {Ha],

Highway and Railway (m),

Regional and local road (m),

Distance of lignite from PP (m),

Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m) and

Natural protected areas (Ha).

Each field alternative is evaluated separately within frame of all this limitation and constrains and the valorisation after that was based on the obtained data and results after assumption of valorisation values. For example the South Siboc field that is analysed below shows the procedure and description of each constrain factor. For Total area of deposit the valorisation point is settled with -0.1 point per each kilometre of land. While the surface area is very important this minus shows that each field gains less minus points

depending in the total area used. In this case, South Siboc field covers an area of 3.7 Km^2, which multiplied by minus 0.1, results with minus 0.37 Points. By geological resource factor it is taken into account that by each 10Mt/ Km^2 of lignite 1 Point will be allocated. This means that favourable ratio between geological resources per square kilometre will get favourable evaluation [224/3.7=60.5 [Mt]/ [Km2]. This gave the total of 6.05 points for this valorisation factor.The same for Mineable Resources [Mt]/ Total Area [Km2]. Favourable ratio is equal to favourable evaluation of the points. They are divided 1 Point for 8[MT]/ [Km2] and based on data this results with 6.37 points.

Next important factor is stripping ration between overburden to Lignite. Point allocation is 5, based by similar ration 1/1 for O/L and based on this than calculations are made. So here for South Siboc the ratio is 0.9/1 and the total points allocated are 5.55. The average calorific value is pointed with 5 points over 8500Kj/Kg;4.5 points for 8400Kj/Kg;4points for 8300Kj/Kg and in South Siboc Case the points allocated reach 4 while the calorific value average is 8300Kj/Kg. For the factor of corresponding PP size the base value is 3 points for each 300MW of PP for the long life period of PP.

This depends on technology as well and this in the South Siboc case derives with average of 3.9 points. Most important impact constrain the resettlement of inhabitants is evaluated with minus points. Each resettled Inhabitant per Mt of lignite is evaluated with minus (-1) point, so this means minus 6.42 points. One of very important factors is the regional dispersion in the future mining activities in order to avoid large scale pollution in one specific area. Each new field apart from existing ones is evaluated with 0.1 Point per Km of distance in order to support the dispersion and regionalization of new energy facilities. (The procedure for the evaluation of the deposits will be illustrated below by an example). While South Siboc field is continuation of active mining activities this results with zero points.

The water availability is for Kosovo conditions very important while of limitation in water resources. Therefore each future lignite field that has access to water for mining and energy production gets 3 points. If the water supply is not available than point allocation is equally to zero. Each new employee in new mining activities brings 0.05 points. In the case for example that number of 30 people will be employed, this means 0.3 points. Extraterritorial jurisdictions of communities possess minus points for the future activities while of political limitation and actual situation in Kosovo. Each [Ha] of extraterritorial land is equal to [-0.15] points. In this case there are no such limitations.

By infrastructure constrains Highways and Railways are equally pointed with minus 0.002 Points per meter and South Siboc field is not affected directly so the result is zero. By regional and local roads each meter of regional and local road is equal to minus 0,001 points. The dispersion distance of new fields from PP(actual ones and future capacities) is estimated that each 100 meter of distance are equal to minus 0.1 Points while this increase the transportation costs.

Below is explanation table about valorisation factors and valorisation points gained from in order to establish a guide about future strategic decisions and development scenarios in lignite exploration and generation capacities. The same evaluation is made for existing mining and energy infrastructure distance

(roads, transmission lines, distribution) (m). Finally each hectare of protected areas is equal to minus 0.01 points. In this case this results from 170 Ha of natural protected areas, multiplied with minus 0.01 is minus 1.7 Points.

Valorisation factors- *South Siboc Field*	Description	Valorisation Values-Points
Total Area [Km2]	Less Km^2 used more positive points. Per each Km^2 used land it is assumed to evaluate with -0.1 Points	19.7x(-0.1)=-1.97
Geological Lignite Resources[Mt]/ Total Area [Km2]	Favourable ratio equal to favourable evaluation. The points are divided 1Point for 10[MT]/[Km2]	224/3.7=60.5[Mt]/[Km2]=6.05
Mineable Resources [Mt]/ Total Area [Km2]	Favourable ratio equal to favourable evaluation. The points are divided 1Point for 8[MT]/[Km2]	190/3.7=51[Mt]/[Km2]=6.37
Stripping Ratio [O/L]	Favourable ratio equal to favourable evaluation. The points are divided 5 Points for 1/1 O/L	0.9:1=5.5
Average Calorific Value	Average calorific value is pointed with 5 points over 8500 Kj/Kg;4.5 points for 8400Kj/Kg;4points for 8300Kj/Kg.	8.300=4
Corresponding Size of TPP [MW]	Each 300 MW are pointed with 3 points	1,000 – 1,400=Av of 3.9
Inhabitants/ Number of affected inhabitants and percentage [%]	Each resettled Inhabitant per Mt of lignite is evaluated with (-0.1) point	1220/190(9.3%)x(-1)=-6.42
Regional dispersion of lignite resources from actual mining	Each new field apart from existing ones is evaluated with 0.1Point per Km of distance	0Km of distance=0
Water availability	Water availability has maximum 3points. If not available is equally to zero	Yes=3
Economical impact	Per each new employee is equal to 0.05 points	30x0.05=0.3
Extraterritorial Jurisdictions[Ha]	Each [Ha] is equal to [-0.15] points	No=0
Highway and Railway [m]	Each meter of Highway and Railways is equal to minus 0,00 2 points	0
Regional and local road [m]	Each meter of regional and local road is equal to minus	2567=-2.567

	0,001 points	
Distance of lignite from PP [m]	Each 1000m of distance are equal to minus 0.1 Points	900=-0.9
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) [m]	Each 1000 meter of distance are equal to minus 0.1 Points	500=-0.5
Natural protected areas(Ha)	Each [Ha] is equal to [-0.15] points	170=-1.7

Table 10-1: Risks, constrains and description sample with evaluation form

The total of points represents the summary of all negative and positive points allocated and the same way is used for all possible future fields.

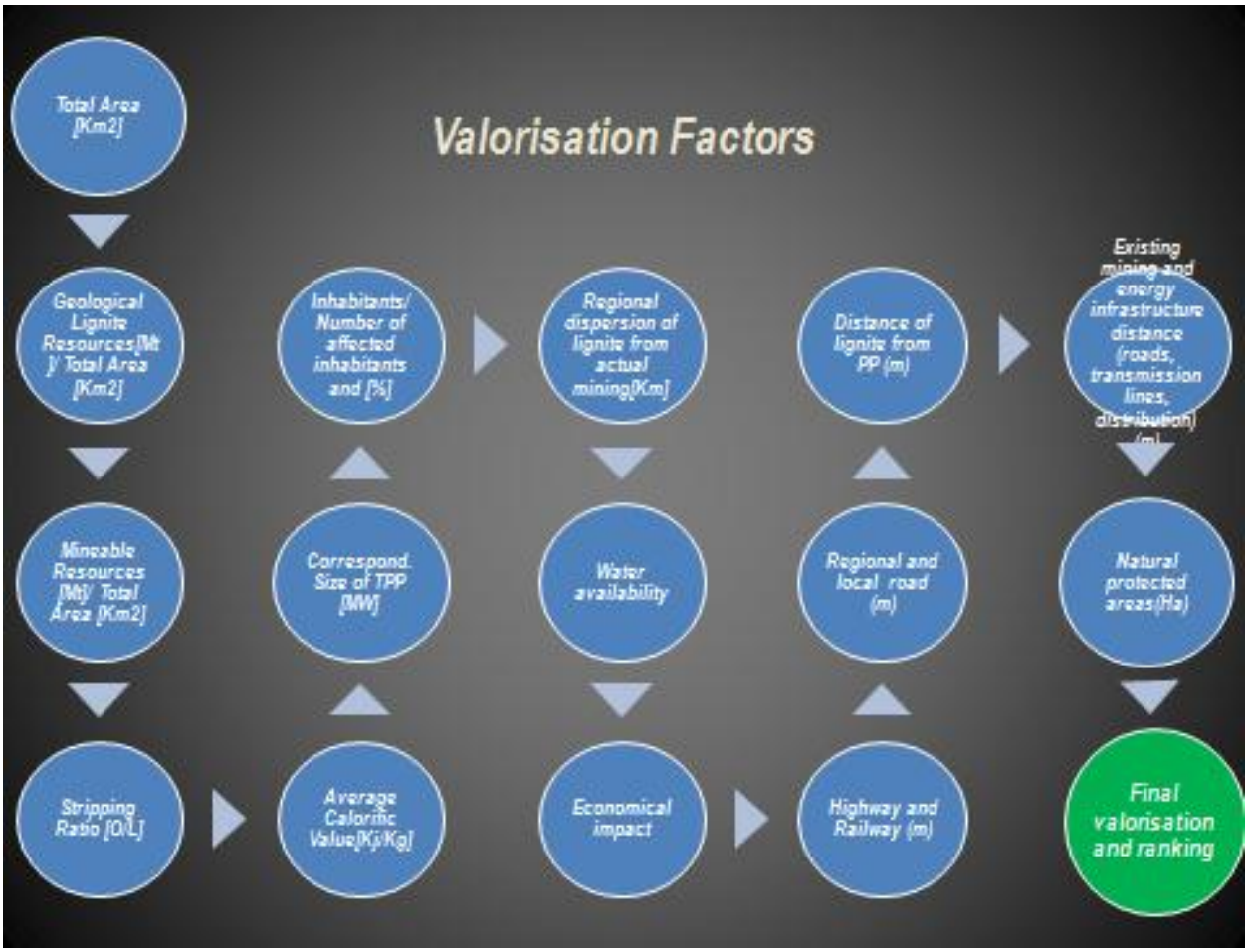


Figure 10-1: Valorization factors

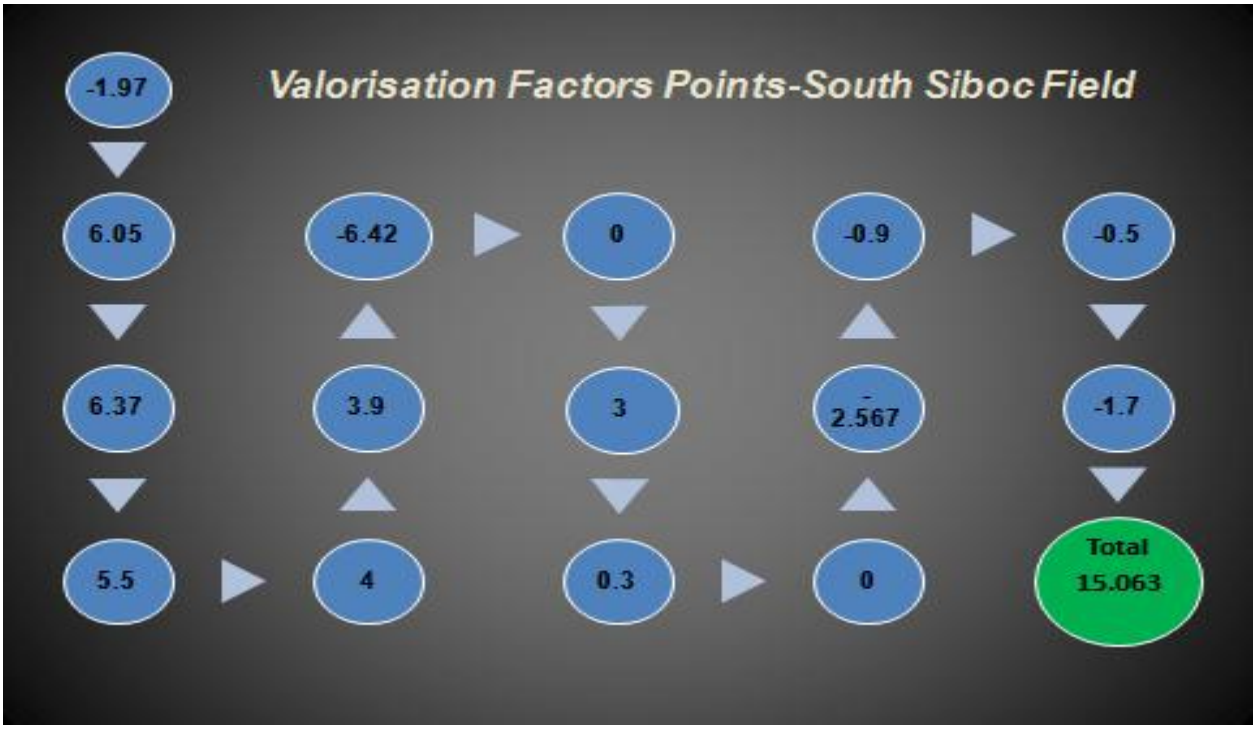


Figure 10-2: Valorisation factor points-South Siboc Field example

Valorization factors and Ranking	South Siboc Field	Siboc Field	Field D	Kosovo Basin- S. Part	South Field	Dukagjini Basin- Area 1	Dukagjini Basin- Area 2	Drenica Basin
Total Area [Km2]	**-0.37**	**-1.97**	**-0.78**	**-13.9**	**-0.8**	**-4.9**	**-4.6**	**-1.8**
Ranking	***1***	***5***	***2***	***8***	***3***	***7***	***6***	***4***
Geological Lignite Resources[Mt]/ Total Area [Km ^{2}]	**6.05**	**5.03**	**5.06**	**1.8**	**6.7**	**0.49**	**0.95**	**2.7**
Ranking	***2***	***4***	***3***	***6***	***1***	***8***	***7***	***5***
Mineable Resources [Mt]/ Total Area [Km ^{2}]	**6.37**	**5.28**	**4.49**	**1.2**	**5.78**	**0.47**	**0.67**	**1.5**
Ranking	***1***	***3***	***4***	***6***	***2***	***8***	***7***	***5***
Stripping Ratio [O/L]	**5.5**	**5.5**	**5.5**	**3.75**	**1.35**	**1.85**	**1.6**	**2.94**
Ranking	**1**	**1**	**1**	**3**	**7**	**5**	**6**	**4**
Average Calorific Value[KJ/kg]	**4**	**4**	**2.5**	**2**	**4**	**4.5**	**6**	**2**

Ranking	***3***	***3***	***4***	***5***	***3***	***2***	***1***	***5***
Corresponding Size of TPP [MW]	**3.9**	**7**	**2**	**13**	**3.3**	**1.5**	**2.8**	**1.7**
Ranking	***3***	***2***	***7***	***1***	***4***	***8***	***5***	***6***
Inhabitants/ Number of affected inhabitants and [%]	**-6.42**	**-8.5**	**-1.01**	**-2.56**	**-4.68**	**-5.6**	**-4.62**	**-18.4**
Ranking	**6**	**7**	**1**	**2**	**4**	**5**	**3**	**8**
Regional dispersion of lignite resources from actual mining	**0**	**0**	**0**	**-3.5**	**0**	**8.85**	**8.5**	**3.85**
Ranking	**1**	**4**	**4**	**5**	**4**	**1**	**2**	**3**
Water availability	**3**	**3**	**3**	**0**	**3**	**3**	**3**	**3**
Ranking	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**1**
Economical impact	**1.5**	**12.5**	**1.25**	**75**	**0.9**	**4**	**3.5**	**6**
Ranking	**6**	**2**	**7**	**1**	**8**	**4**	**5**	**3**
Extraterritorial jurisdictions[Ha]	**0**	**-9.75**	**-1.15**	**-10.65**	**-2.25**	**-16.5**	**-16.5**	**0**
Ranking	**1**	**4**	**2**	**5**	**3**	**6**	**6**	**1**
Highway and Railway (m)	**0**	**0**	**0**	**-180**	**0**	**0**	**-2.76**	**0**
Ranking	**1**	**1**	**1**		**1**	**1**	**2**	**1**
Regional and local road (m)	**-2.567**	**-1.56**	**-5.57**	**-3.8**	**-3.567**	**-12.3**	**-2.75**	**-7.45**
Ranking	**2**	**1**	**6**	**5**	**4**	**8**	**3**	**7**
Distance of lignite from PP (m)	**-0.9**	**-0.75**	**-0.85**	**-18.5**	**-1.25**	**-0.5**	**-0.95**	**-2.5**
Ranking	**4**	**2**	**3**	**8**	**6**	**1**	**5**	**7**
Existing mining and energy infrastructure distance (roads, transmission lines, distribution) (m)	**-0.5**	**-0.25**	**-0.95**	**-16.5**	**-0.75**	**-0.5**	**-0.95**	**-2.5**
Ranking	**2**	**1**	**4**	**6**	**3**	**2**	**4**	**5**
Natural protected areas(Ha)	**-1.7**	**-5.2**	**-2.5**	**-29.02**	**-1.5**	**-4.78**	**-1.78**	**-0.56**
Ranking	**3**	**7**	**5**	**8**	**2**	**6**	**4**	**1**

Table 10-2: Total valorisation point allocation and ranking by specific constrain parameters

10.2. Evaluation and Development of Ranking Guide for of Further Lignite Exploration

Based on specific characteristics at the beginning risk factors of a lignite mine has been identified on each step of the value creation chain from the lignite deposit, constrains and positive impacts, through a mine and with final aim to support the fuel supply for generation power plants until the sale of electricity on the energy market. The key risk factors (e.g., total area of the field, settlements, amount of lignite within the deposit and its quality and quantity, amount of overburden, extraterritorial areas, infrastructure and natural protected areas) and procedures used to define the constrain classes were described above. The sustainable use and management of natural resources is a relatively new issue and here are presented some of the main strategic points and risk factors that have a major influence on the use of lignite resources, and illustrates some challenges to policy integration. Managing lignite resources in a sustainable way has many different points of intervention: resource extraction, production and consumption, management of wastes and emissions, total land use, estimation of geological lignite resources, mineable resources, stripping ratio, average calorific value, corresponding size of TPP, number of affected inhabitants, regional dispersion of lignite resources from actual mining-distance, water availability, economic impact, extraterritorial jurisdictions of communities, highway, railway, regional and local road, distance of lignite from PP, existing mining and energy infrastructure distance (roads, transmission lines, distribution) and natural protected areas. On the graph below all this kinds of constrains are presented separately and different types of constrains have been weighted differently as they are of different importance. Part of the constrain factors are evaluated with minus points while mining activities are space and land consuming, so this has negative impact in the life conditions. The total area used is weighted with minus 0.1 point per each Km^2 .The geological reserves are scored with 1point per each 10 Mt of lignite, mineable reserves are evaluated with 1 point per each 8 Mt of lignite, stripping ratio with 5 points for favourable conditions by 1/1 between lignite and overburden, quality is evaluated depending on calorific value of fuel (5 points for 8500 Kj/Kg), power plant size takes 1 point per each 300MW size. The human beings-resettlement constrain is weighted with minus 0.1 score for resettled inhabitant per MT of fuel, regional dispersion of future mining activities gains 0.1 point per Km distance from current mining activities in order to support the regionalization of future generation and mining activities in Kosovo. Because Kosovo is poor in water resources the water availability factor is evaluated with 3 points, each new employee that will be employed by future mining activities brings 0.05 points. One specific constrain factor is "Extraterritorial Jurisdiction" over possible parts of future mining areas. This is part of the e Constitutional regulation in Kosovo and the Serbian Orthodox Church has such rights that in some areas can affect the lignite fields as well. Each Ha of such "Extraterritorial Jurisdiction" is evaluated with minus 0.15 points. Every Highway and Railway meter constrain in future mines is equal to minus 0.002 points and for regional and local infrastructure with 0.001. While transportation costs are also very important for fuel cost, the Km distance factor from mine to PP is equal to minus 0.1 point. The same factor is used for the distance of mining areas from existing or future mining and generation infrastructure (roads, railway, and transmission lines). Finally the protected sites are estimated with weighting constrain factor from minus 0.15 points for

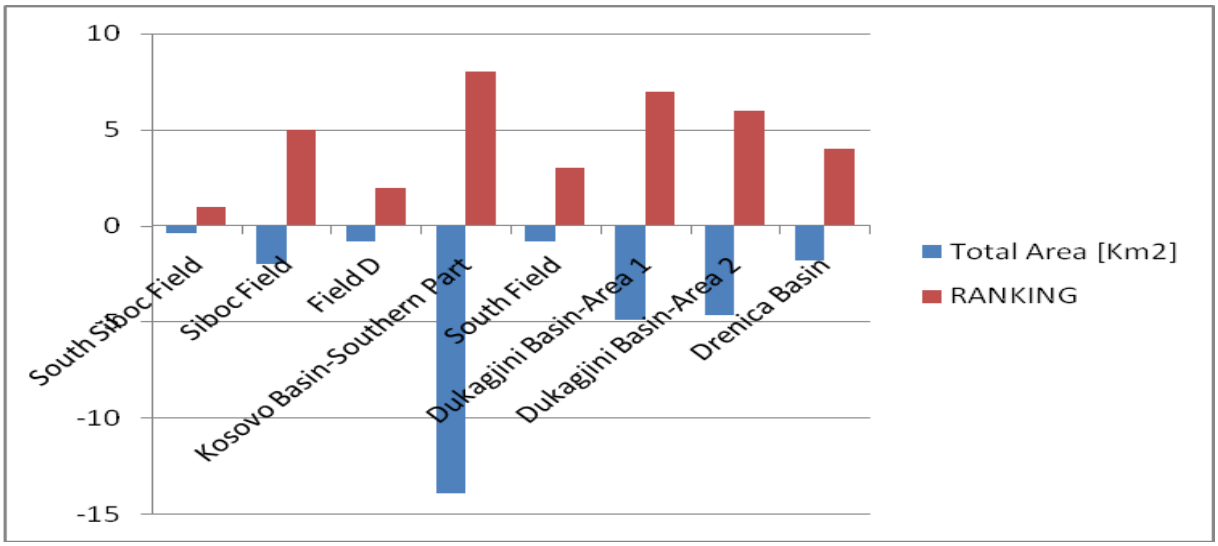
each Ha that can be in conflict with possible excavation of fuel. Below are graphs with analysis and valorisation for each risk factor and constrain, as well are included positive factors. Based in those the Point Method Ranking is generated and will serve as future guide for the decision making in lignite utilization for long term energy supply of the country.

10.2.1. Ranking of Lignite Field Deposits Versus Different Constrain Factors

The most attractive lignite deposits selected should be included in future policy on energy and then their protection should be ensured in spatial planning documents. Although there are shortcoming of spatial planning regarding real estates with mineral deposits and as well for other limitation factors is very difficult to obtain the data below are presented the tables with ranking of attractive lignite fields comparing to each class of constrains.The results for all above mentioned alternatives are shown in the tables and graphs below.

Valorization factors/Points	South Siboc Field	Siboc Field	Field D	Kosovo Basin -Southern Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
Total Area [Km^2]	-0.37	-1.97	-0.78	-13.9	-0.8	-4.9	-4.6	-1.8
Ranking	1	5	2	8	3	7	6	4

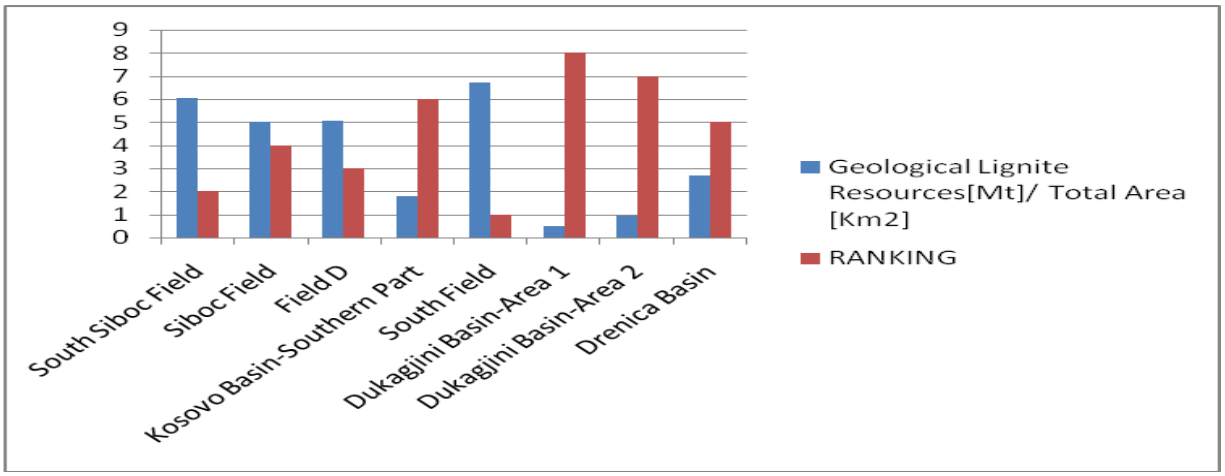
Table 10-3: Valorisation and ranking for total area use



Graph 10-1: Valorisation and ranking for total area use

Valorization factors/Points	South Siboc Field	Siboc Field	Field D	Kosovo Basin-Southern Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
Geological Lignite Resources[Mt]/ Total Area [Km^2]	6.05	5.03	5.06	1.8	6.7	0.49	0.95	2.7
Ranking	2	4	3	6	1	8	7	5

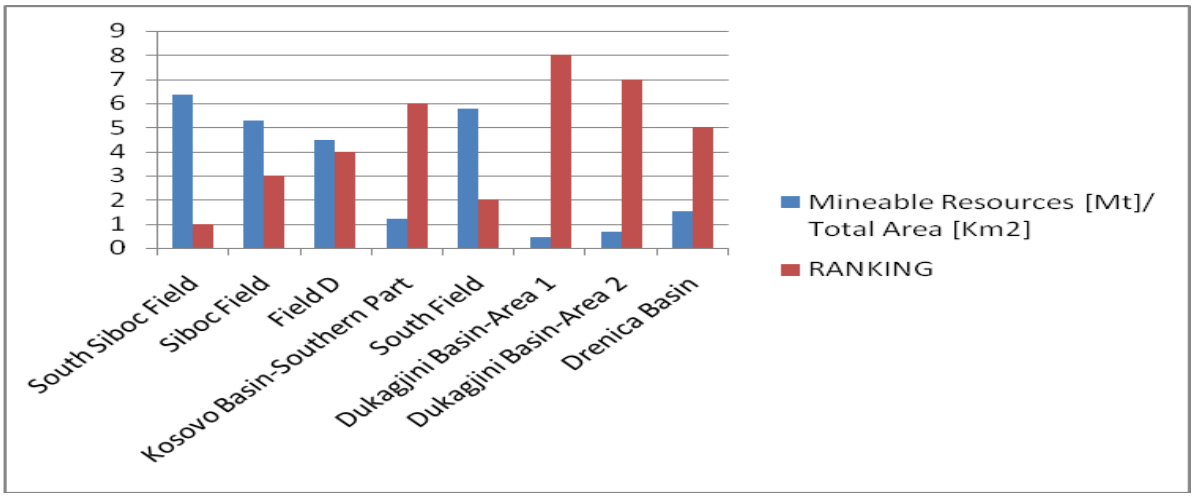
Table 10-4: Valorisation and ranking based on geological reserves



Graph 10-2: Valorisation and ranking based on geological reserves

Valorization factors/Point	South Siboc Field	Siboc Field	Field D	Kosovo Basin-Southern Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
Mineable Resources [Mt]/ Total Area [Km^2]	6.37	5.28	4.49	1.2	5.78	0.47	0.67	1.5
Ranking	1	3	4	6	2	8	7	5

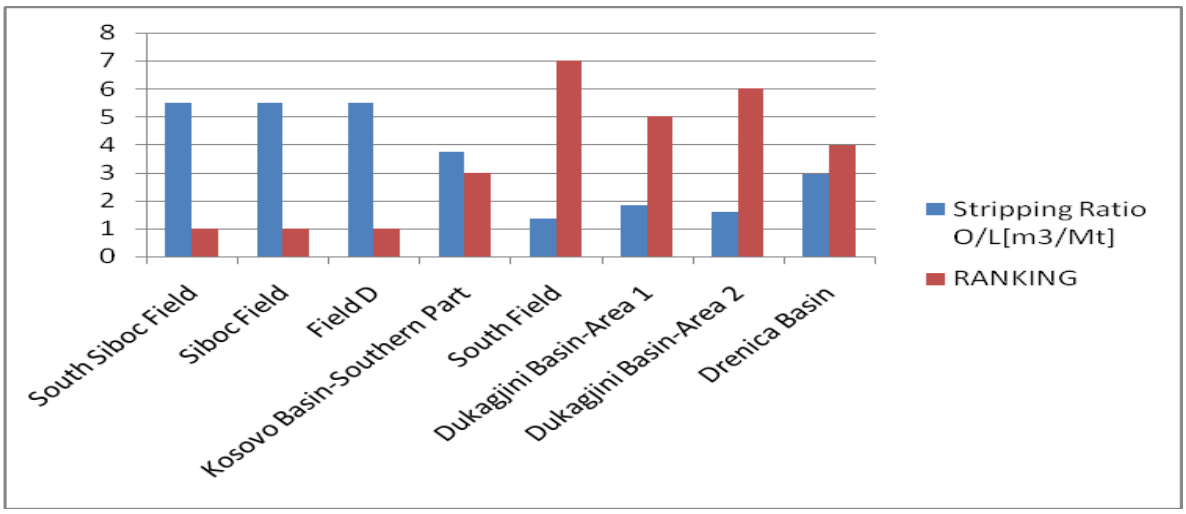
Table 10-5: Valorisation and ranking based on mineable resources



Graph 10-3: Valorisation and ranking based on mineable resources

Valorization factors/Points	South Siboc Field	Siboc Field	Field D	Kosovo Basin-Southern Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
Stripping Ratio [O/L]	5.5	5.5	5.5	3.75	1.35	1.85	1.6	2.94
Ranking	1	1	1	3	7	5	6	4

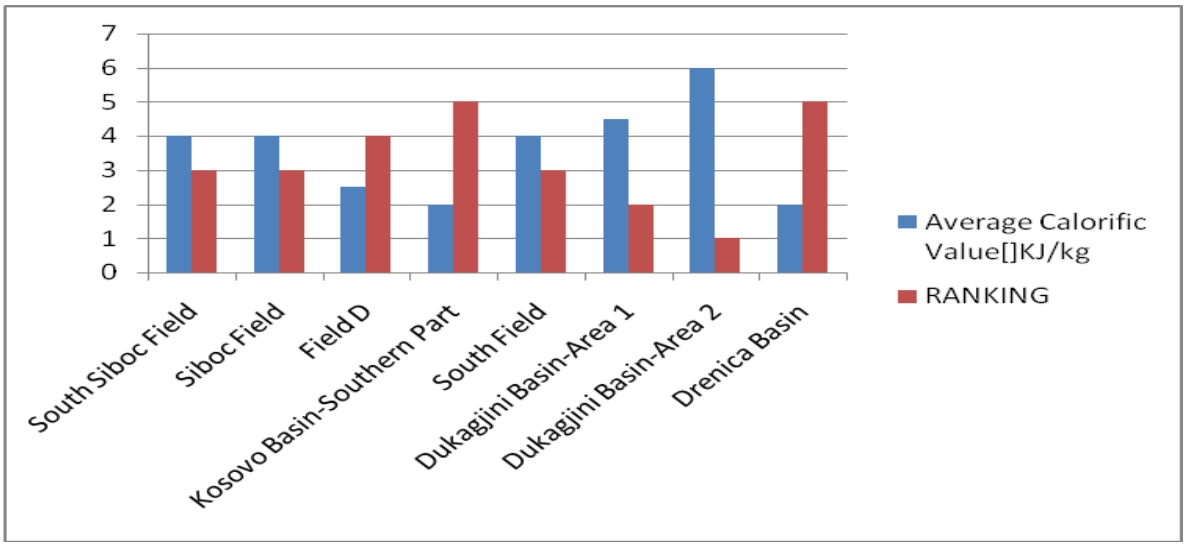
Table 10-6: Valorisation and ranking based on stripping ratio O/L



Graph 10-4: Valorisation and ranking based on stripping ratio O/L

Valorization factors/Points	South Siboc Field	Siboc Field	Field D	Kosovo Basin-Southern Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
Average Calorific Value[KJ/kg]	4	4	2.5	2	4	4.5	6	2
Ranking	3	3	4	5	3	2	1	5

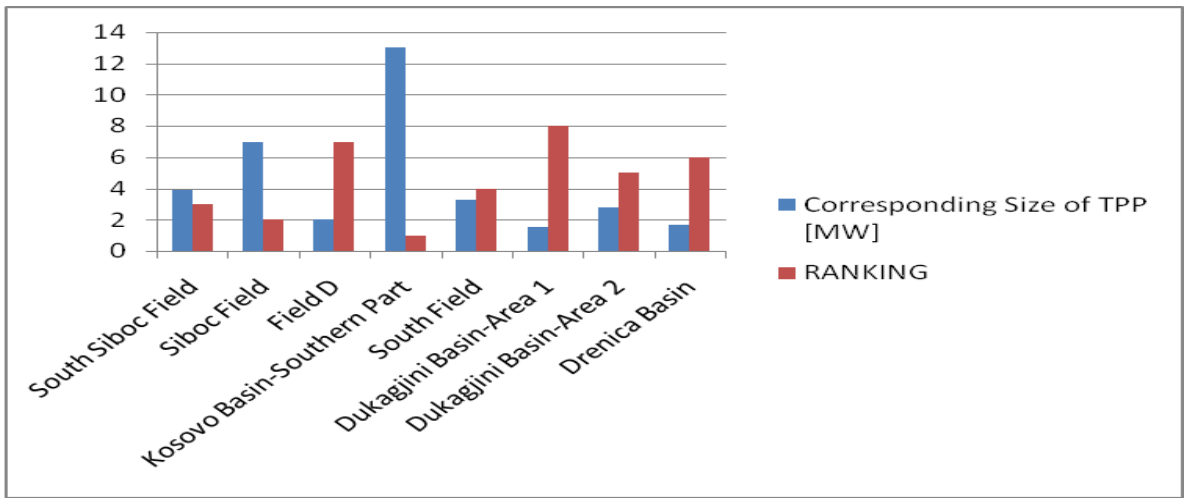
Table 10-7: Valorisation and ranking based on calorific value



Graph 10-5: Valorisation and ranking based on calorific value

Valorization factors/Points	South Siboc Field	Siboc Field	Field D	Kosovo Basin-Southern Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
TPP Corresponding Size [MW]	3.9	7	2	13	3.3	1.5	2.8	1.7
Ranking	3	2	7	1	4	8	5	6

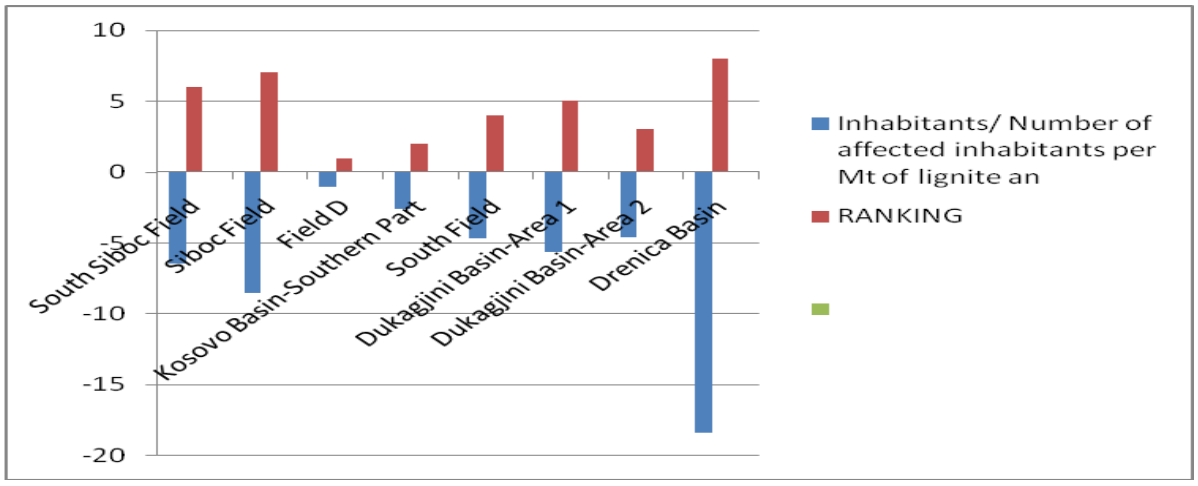
Table 10-8: Valorisation and ranking based on PP size



Graph 10-6: Valorisation and ranking based on PP size

Valorization factors-	*South Siboc Field*	*Siboc Field*	*Field D*	*Kosovo Basin-South-Part*	*South Field*	*Dukagjini Basin-Area 1*	*Dukagjini Basin-Area 2*	*Drenica Basin*
Inhabitants/ Number of affected inhabitants	*-6.42*	*-8.5*	*-1.01*	*-2.56*	*-4.68*	*-5.6*	*-4.62*	*-18.4*
Ranking	*6*	*7*	*1*	*2*	*4*	*5*	*3*	*8*

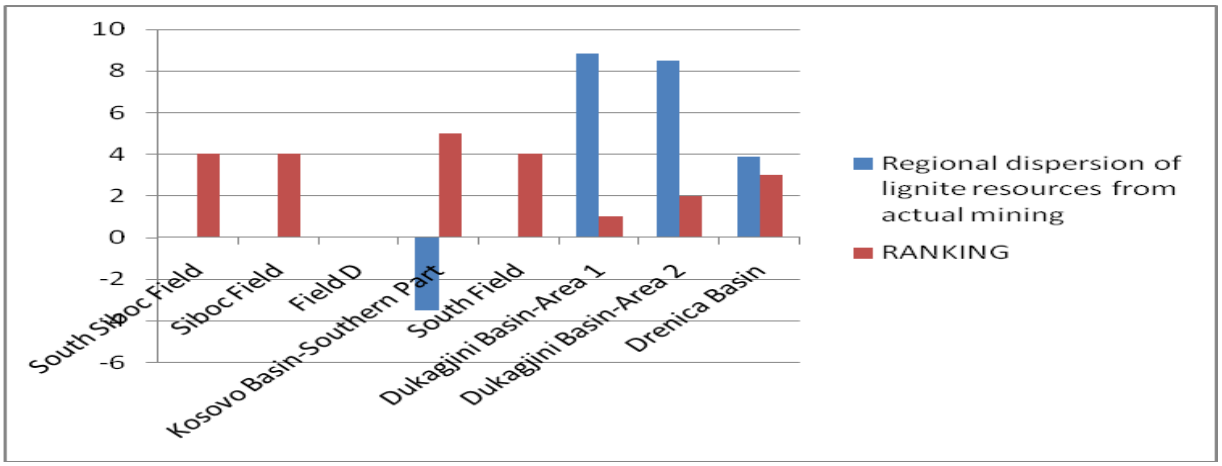
Table 10-9: Valorisation and ranking based on resettlement of inhabitants



Graph 10-7: Valorisation and ranking based on resettlement of inhabitants

Valorization factors/Points	South Siboc Field	Siboc Field	Field D	Kosovo Basin-Southern Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
Regional dispersion of lignite resources	0	0	0	-3.5	0	8.85	8.5	3.85
Ranking	4	4	0	5	4	1	2	3

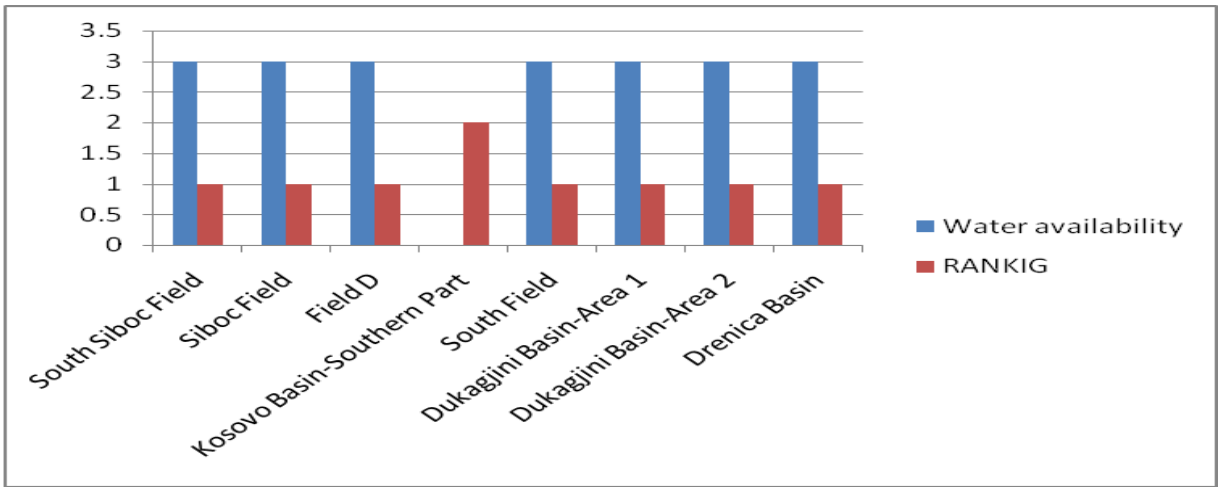
Table 10-10: Valorisation and ranking based on regional dispersion of future activities



Graph 10-8: Valorisation and ranking based on regional dispersion of future activities

Valorization factors/Points	*South Siboc Field*	*Siboc Field*	*Field D*	*Kosovo Basin-Southern Part*	*South Field*	*Dukagjini Basin-Area 1*	*Dukagjini Basin-Area 2*	*Drenica Basin*
Water availability	*3*	*3*	*3*	*0*	*3*	*3*	*3*	*3*
Ranking	*1*	*1*	*1*	*2*	*1*	*1*	*1*	*1*

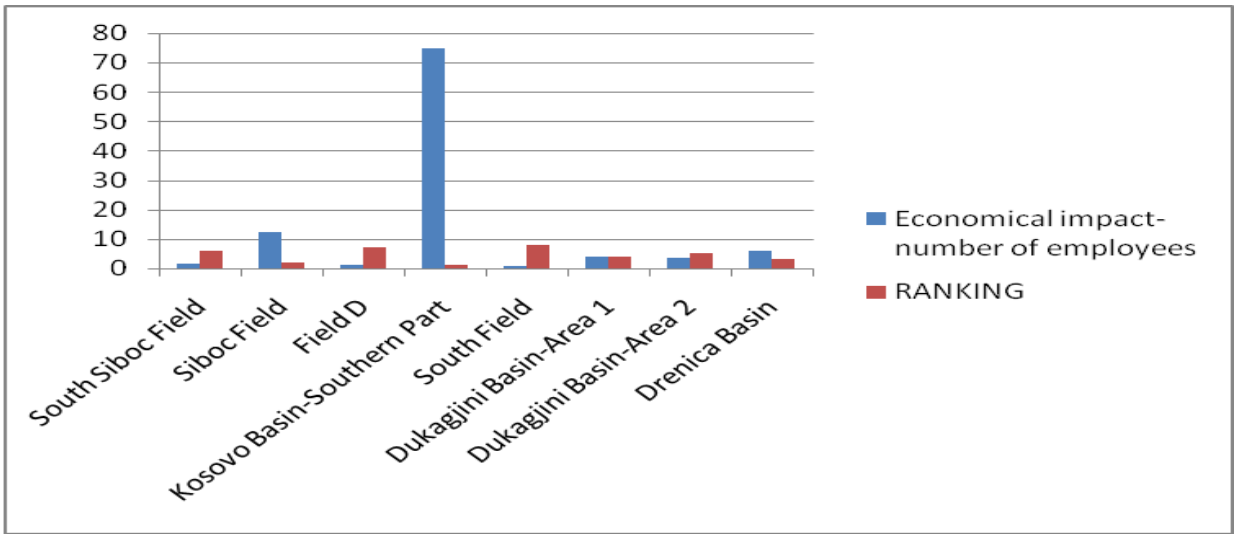
Table 10-11: Valorisation and ranking based on water supply



Graph 10-9: Valorisation and ranking based on water supply

Valorization factors/Points	South Siboc Field	Siboc Field	Field D	Kosovo Basin-Southern Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
Economic impact	1.5	12.5	1.25	75	0.9	4	3.5	6
Ranking	6	2	7	1	8	4	5	3

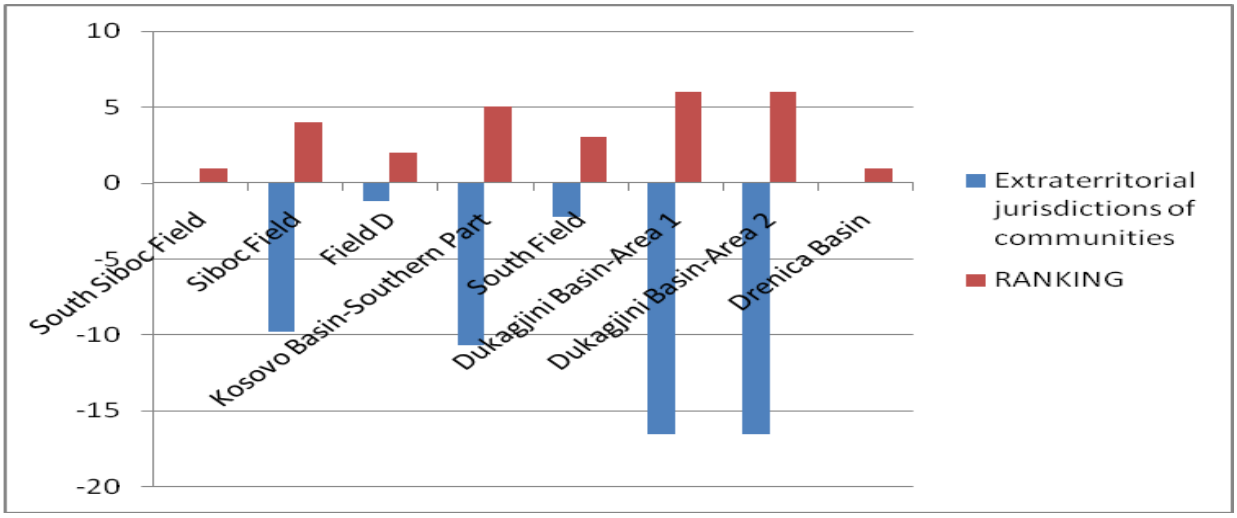
Table 10-12: Valorisation and ranking based on economical supply



Graph 10-10: Valorisation and ranking based on economical supply

Valorization factors/Points	South Siboc Field	Siboc Field	Field D	Kosovo Basin-South Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
Extraterritorial jurisdictions of communities	0	-9.75	-1.15	-10.65	-2.25	-16.5	-16.5	0
Ranking	1	4	2	5	3	6	6	1

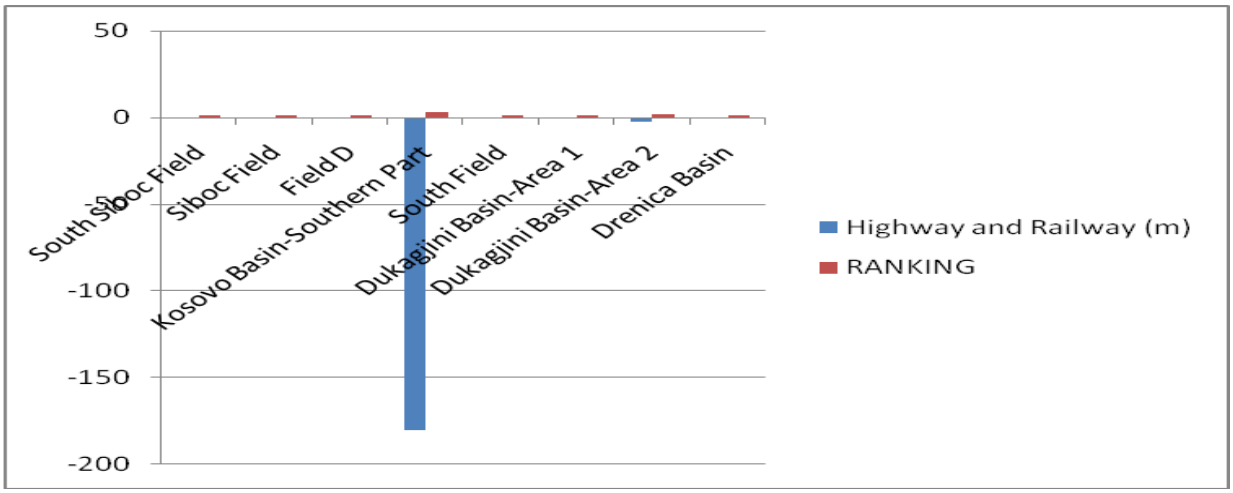
Table 10-13: Valorisation and ranking based on extraterritorial areas



Graph 10-11: Valorisation and ranking extraterritorial areas

Valorization factors/Points	South Siboc Field	Siboc Field	Field D	Kosovo Basin-Southern Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
Highway and Railway (m)	0	0	0	-180	0	0	-2.76	0
Ranking	1	1	1	3	1	1	2	1

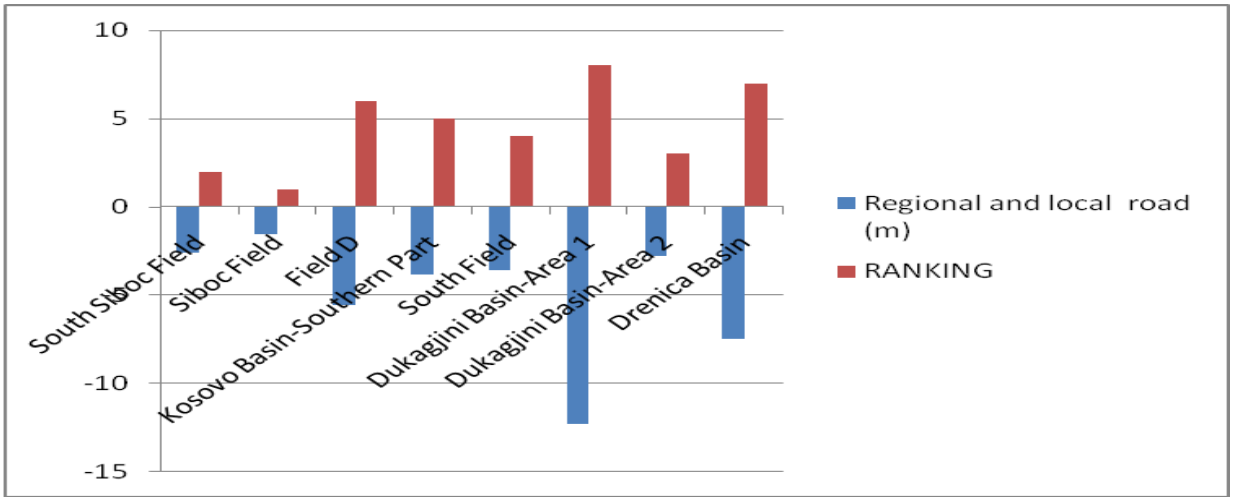
Table 10-14: Valorisation and ranking by affected highway and railway



Graph 10-12: Valorisation and ranking by affected highway and railway

Valorization factors/Points	South Siboc Field	Siboc Field	Field D	Kosovo Basin-Southern Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
Regional and local road (m)	-2.567	-1.56	-5.57	-3.8	-3.567	-12.3	-2.75	-7.45
Ranking	2	1	6	5	4	8	3	7

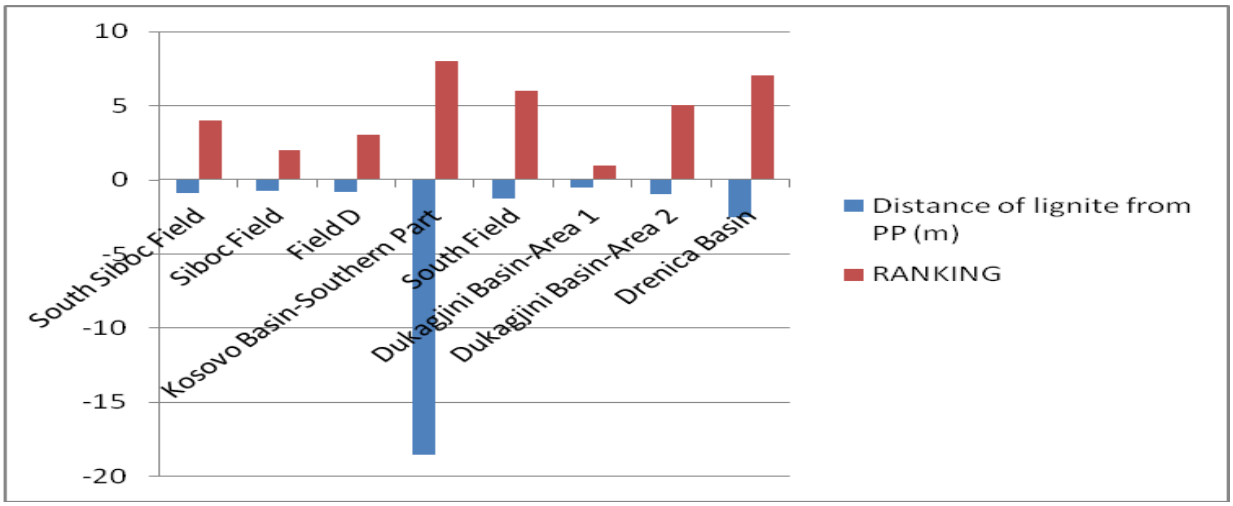
Table 10-15: Valorisation and ranking based on affected regional and local road



Graph 10-13: Valorisation and ranking based on affected regional and local road

Valorization factors/Points	South Siboc Field	Siboc Field	Field D	Kosovo Basin-Southern Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
Distance of lignite from PP (m)	-0.9	-0.75	-0.85	-18.5	-1.25	-0.5	-0.95	-2.5
Ranking	4	2	3	8	6	1	5	7

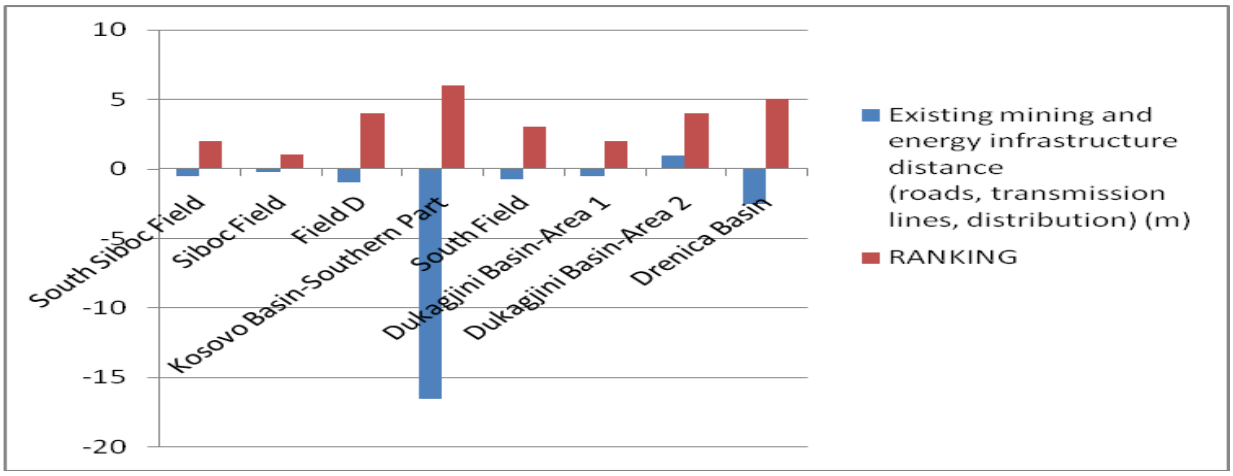
Table 10-16: Valorisation and ranking based on PP distance



Graph 10-14: Valorisation and ranking based on PP distance

Valorization factors/Points	South Siboc Field	Siboc Field	Field D	Kosovo Basin-South Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
Existing mining and energy infrastructure distance (m)	-0.5	-0.25	-0.95	-16.5	-0.75	-0.5	0.95	-2.5
Ranking	2	1	4	6	3	2	4	5

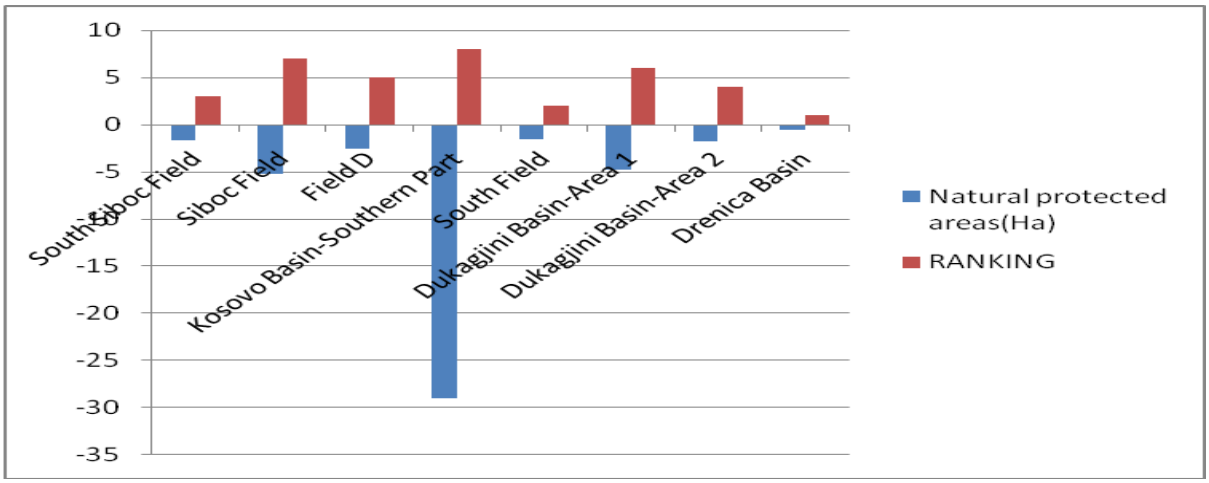
Table 10-17: Valorisation and ranking based on eexisting mining and energy infrastructure



Graph 10-15: Valorisation and ranking based on eexisting mining and energy infrastructure

Valorization factors/Points	South Siboc Field	Siboc Field	Field D	Kosovo Basin-Southern Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
Natural protected areas (Ha)	-1.7	-5.2	-2.5	-29.02	-1.5	-4.78	-1.78	-0.56
Ranking	3	7	5	8	2	6	4	1

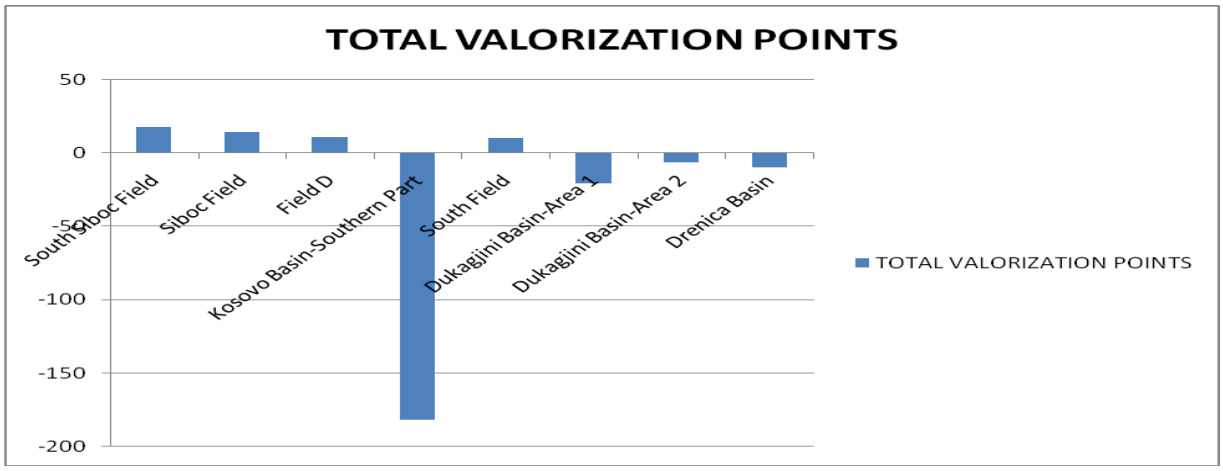
Table 10-18: Ranking of Fields based on natural protected area constrains



Graph 10-16: Valorisation and ranking *based on natural protected area constrains*

10.3. Overall Assessment

Based on the constrain factors, possible future regional development mining activities and lignite deposits, based on point method finally is made an overall assessment, in which a balance between life, space and potential constrains of each deposit is assessed. The Analytical Process, enables the estimation of mineral deposits in a more complex manner and for this purpose, a multi–criteria and all factors that can have an influence on the attractiveness of their development were taken into account. In Kosovo case sspecial consideration will be for the deposits that occur as connection fields of existing mines since it is not necessary to start open new mines for short term fuel supply. The classification is achieved due to the fuel demand and necessity to produce domestic energy in order to secure supply and prepare for next steps of development in the energy sector. Particularly positive impacts have fields with low specific land use and low level of resettlement while this helps to rank those fields as a higher priority class. As previously mentioned, the goal of the valorization of lignite deposits and the establishment of their development guide and strategic management means the selection the most future fuel fields that are attractive for development and then their protection against investments other than mining. Protection of lignite deposits is important for the energy security of Kosovo. One of the aims of Kosovo's policy on resource management and energy is to ensure stable fuel and energy supply at a level that ensures the satisfaction of national needs and at prices acceptable by the economy and society with the assumption of the optimal use of national raw energy resources. For Kosovo, where approx.97% of the power industry is based on lignite, not only recognition of the resources but also their valorization concerning attractiveness for development and establishment of a ranking of lignite deposits is very important. The most attractive deposits should be included in Kosovo's policy on energy and this should be reflected in the appropriate provisions being made in strategic documents ensuring the protection of deposits. The nation of Kosovo will benefit from secure supply of lignite for future generation that will support economic growth and public revenues.



Graph 10-17: Total valorisation points of future lignite fields

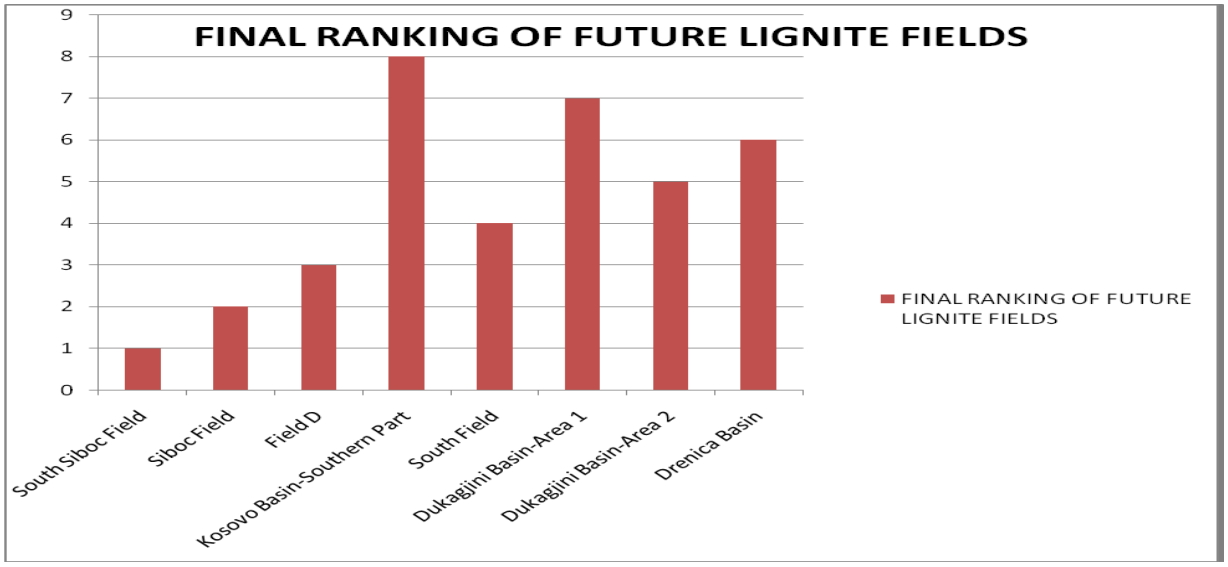


Figure 10-18: Final ranking of future lignite fields

	South Siboc Field	Siboc Field	Field D	Kosovo Basin-Southern Part	South Field	Dukagjini Basin-Area 1	Dukagjini Basin-Area 2	Drenica Basin
TOTAL VALORIZATION POINTS	**17.863**	**14.3**	**10.99**	**-181.7**	**10.23**	**-20.42**	**-5.99**	**-9.52**
FINAL RANKING OF FUTURE LIGNITE FIELDS	***1***	***2***	***3***	***8***	***4***	***7***	***5***	***6***

Table 10-19: Final ranking of lignite fields

10.4. Evaluation of Regional Based Developments for Further Mining Activities

The following assessment shows the ranking of all fields in different priority classes and this is based in total ranking of different calculation from earlier constrain class analysis, specific land use for Mt of lignite as well taking into account finally the overburden/lignite ratio and other mention constrain factors. All this

make us possible to define priorities for long term development in Kosovo. Priorities are differently coloured, beginning from green (high priority), yellow [medium priority] and red [low priority].

Field Name	Valorization Points	Ranking
South Siboc Field	17.863	1
Siboc Field	14.33	2
Field D	10.99	3
South Field	10.23	4
Dukagjini Basin-Area 2	-5.99	5
Drenica Basin	-9.52	6
Dukagjini Basin-Area 1	-20.42	7
Kosovo Basin-Southern Part	-181.68	8

Table 10-20: Valorisation points and final field ranking

Except the final ranking it was the aim as well to have an idea about the regionalization of future important lignite mining activities and group them in regional base according to their value and importance. Below it is presented the importance of fields within same geographic and regional position.

Field Name	Total Rank	Overburden/ Lignite Striping Ratio	Specific Land Use[m^2/Mt]	Priority
South Siboc Field	1	0.9/1	11.83521	high
Siboc Field	2	0.9/1	19.89899	high
Field D	3	0.9/1	19.74684	high
South Field	4	2.8/1	14.89758	high
Kosovo Basin Southern	8	1.34/1	53.46154	low
Dukagjini Basin-Area 1	7	3.1/1	21.236	low/medium
Dukagjini Basin-Area 2	5	1.7/1	23.509	medium
Drenica Basin	6	7955	36.003	medium

Table 10-21: Ranking of Fields Based on Regionalization of Mining Activities

With light green colour are ranked fields within central located Kosovo Basin lignite reserves were fields from 1 to 4 are with high importance estimated and the main area of the lignite reserves that belongs to Kosove basin-southern part shows low importance as a result of many constrains as it is shown before.

With yellow the next region with lignite reserves known as Dukagjini Basin, shows two lignite areas, where one is from medium importance and the other one is predicted to be low valorised because of hug constrains. The last region-Drenica basin can be the middle or long term solution even that there are limited reserves compared to the previous basins. The final rating and the division into priority classes and associated priority rankings would serve as a basis for decision making for the long-term fuel security supply for energy production with domestic lignite to the State of Kosovo.

10.5. Evaluation of Possible Fuel Reserves and Review of the Supply

The research carried out for the purpose of long term energy supply for Kosovo Lignite resources indicated the need to address numerous constrains and opposing interests in the area concerned. This required the clear strategy to focus on harmonizing the economic, social and spatial aspects of developing a mining-energy-industrial system and its surroundings, devising the new ways for the protection of local population interests and use of novel approaches in dealing with the environmental consequences of lignite exploitation and processing.

The area wherein Kosovo lignite deposits are is impacted with diverse constraining interests, including insufficient and uneven development, extremely large overall and especially agrarian population density (among the highest in Europe), unemployment and a sizable portion of the grey economy. The environmental effects of possible mining activities in a situation of this kind were revealed by the early stages of research in all segments of economic, social and spatial development, along with a high degree of environmental degradation. The main constrains in the lignite area are the one between mining and population, mining and agriculture, mining and extraterritorial areas, mining and water resources as well mining and infrastructure. Therefore, a substantial part of the research was related to the conditions of settlement and infrastructure relocation, population resettlement and measures to relieve the tensions and prevent the outbreak of potential constrains in future mining activities. Taking all those data into account and in view of the constrain remain the mountain and viewing the technical planning of the geological reserves of lignite in Kosovo, the following recoverable masses for the various planning alternatives are obtained:

• 5701 Mt of Lignite's in the first alternative

• 4197 Mt of Lignite in the second alternative

Thus areas outside of the defined study area, like Babush basin located in south from Kosovo south part basin is excluded, because of low fuel potential and high constrain class. In this regard it is analyzed the situation for secure energy supply of Kosovo for long term period with an lignite yearly demand about 25 Mt

of lignite, than it is assumed that Kosovo has secure energy production for own needs and possible export in the region over next hundreds of years. Below are analysed possible energy supply and duration for both alternatives and specific fields individually. The base for assumption are estimations that new TPP as main consumer of lignite will consume in base load approximately 2M of lignite per annum and according to this scenario below data are obtained:

	Alternative 1	Alternative 2
Lignite Quantity [Mt of Lignite]	5702	4197
Total Energy Production Capacities [MW]	19490	9590
Duration (Years)	32.9	54,7

Table 10-22: Fuel Supply Duration Period- Alternative 1 and Alternative 2-

Based on regional development scenario for further mining and generation activities the priority fields defined above for middle term period are analysed and compared with the possible exploitation of those areas (Siboc Field. Field D and South Field) and an assessment about secure energy production based on domestic lignite is made like below:

Regional development scenario-Kosovo Central Basin	Alternative 1	Alternative 2
Lignite Quantity –Siboc, Field D and South Field[Mt of Lignite]	1922	1647
Total Energy Production Capacities [MW]	4300	3600
Duration (Years)	55.87	57.18

Table 10-23: Fuel Supply Duration Period from High Priority Fields- Alternative 1 and Alternative 2

In the following table, the lignite stocks within the defined region of Dukagjini lignite basin are evaluated based in the regional development scenario and according to this data the duration of those resources is approximated.

Regional development scenario-Dukagjini Basin	Alternative 1	Alternative 2
Lignite Quantity –Dukagjini Area 1 and2 [Mt of Lignite]	660	480
Total Energy Production Capacities [MW]	1690	1490
Duration (Years)	48.82	40.26

Table 10-24: Fuel Supply Duration Period from Medium Priority Fields- Alternative 1 and Alternative 2

The possible exploitation of areas with like Drenica basin it is more reliable for long term planning beyond 80-100 years also in terms of regionalization. This is based in the scenario that until this time the environmental damages from mining activities around the Kosovo basin in centre of Kosovo will be minimized and the water availability from Iber-Lepenc hydro system as well will be available to supply the mining and generation activities in Drenica region. According to this data in the table below shows the possibility of energy production beyond middle term scenario.

Regional development scenario-Drenica Basin	Alternative 1	Alternative 2
Lignite Quantity –Drenica Basin [Mt of Lignite]	500	270
Total Energy Production Capacities[MW]	500	300
Duration (Years)	125	108

Table 10-25: Fuel Supply Duration Period from Low Priority Fields- Alternative 1 and Alternative 2

According to the scenarios above for future activities in mining and generation sectors in Kosovo is rather important to decide about the way toward. If it decided to continue with most favourable economic variant of new capacities than the classification into the three priority classes for the energy production based on domestic raw materials that is developed above shows the rating priority classes in general and this alternative includes:

Alternative 1 – General ranking and utilization:

- Four field deposits with high priority (South Siboc Area, Siboc Field, South field and Field D)
- Two field deposits with medium priority (Dukagjini area 2 and Drenica Basin)
- Two field deposits with low priority (Kosovo Basin southern part and Dukagjini area 1)

Despite this the next alternative is regional dispersion of resource utilization in order to ensure better environmental conditions and regional economic development. Below the summary of the results for these projection alternatives is:

Alternative 2 – Regional resource dispersion ranking and utilization

- Kosovo Basin located in centre of the country includes according to the data obtained after analysis four fields with high priority (South Siboc Area, Siboc Field, South Field, and Field D) and Kosovo basin-southern part that is predicted from hug constrains and this shows low priority in regard of possible exploitation
- The Dukagjini Basin located in southern part of the country includes two areas from which Area 2 shows high and Area 1 is ranked as medium important for this regional resource utilization.

- Third possible regional located lignite basin-Drenica basin, is ranked as important for this region and offers possibility for generation support in long term view. Below in the table are summarized regional based priorities and final ranking of the fields.

	Field Name	Total Rank	Overburden/ Lignite Striping Ratio	Specific Land Use[m^2/Mt]	Priority
Regionalization 1	South Siboc Field	1	0.9/1	11.83521	high
	Siboc Field	2	0.9/1	19.89899	high
	Field D	3	0.9/1	19.74684	high
	South Field	4	2.8/1	14.89758	high
	Kosovo Basin Southern	8	1.34/1	53.46154	low
Regionalization 2	Dukagjini Basin-Area 1	7	3.1/1	21.236	medium
	Dukagjini Basin-Area 2	5	1.7/1	23.509	high
Regionalization 3	Drenica Basin	6	7955	36.003	high

Table 10-26: Priority ranking by regionalization option

10.6. Recommendations

Priorities for the development of mining and energy sector in Kosovo until 2050 and beyond have to do with the construction of new thermal power plants and in that relation the opening of new open pits is necessity. These capital investment efforts will be preceded by extensive research, elaboration of development and technical documentation, adoption of a Spatial Plan and Sector Strategies. In same period of time numerous accompanying activities will also take place, being highly important from the point of view or spatial organization and arrangement, e.g. relocation of several settlements, extraterritorial areas, water resources, air pollution specifically in short term because of old technologies used, relocation of the Sitnica river and its tributaries, construction of reservoirs, relocation of a part of major infrastructure and other facilities, formation of internal spoil dumps, start up of organized recultivation of the damaged land, etc.

In this period the Mining Energy Industry Sector will also be the scene for the solution of numerous general development problems, including most importantly: uneven regional development, unemployment, communal equipping of settlements, construction of social standard facilities, especially in villages, etc. Moreover, taking into account current energy policy developments in Kosovo and around, the strategic vision is to create a long-term security of supply of energy resources in order to meet the demand and support the economical development and results of this study should therefore seek a period up to 40 years with possible solutions for time beyond as well.

Regarding the future supply and lignite demand the priority for the extraction of lignite has to be based in high priority fields that are shown in tables above. One of the most urgent actions is to get the South Siboc mine development in order to have smooth shift of mining activities from short to medium term scenario that will continue with opening activities in Siboc field, South Field and Field D. The time required to vacate the land for construction and develop the mine up to the point where lignite is delivered to the power plant is longer than the time for the power generation. Resettlement of the area for the mine development around the Siboc village should be started immediately. Therefore in a first stage, the lignite extraction and supply to energy generators for the time up to 2050 shall be based on regional development in centre of Kosovo with an extension of mining and generation activities beyond in region of Dukagjini and later on from the lignite fields in Drenica lignite basin.

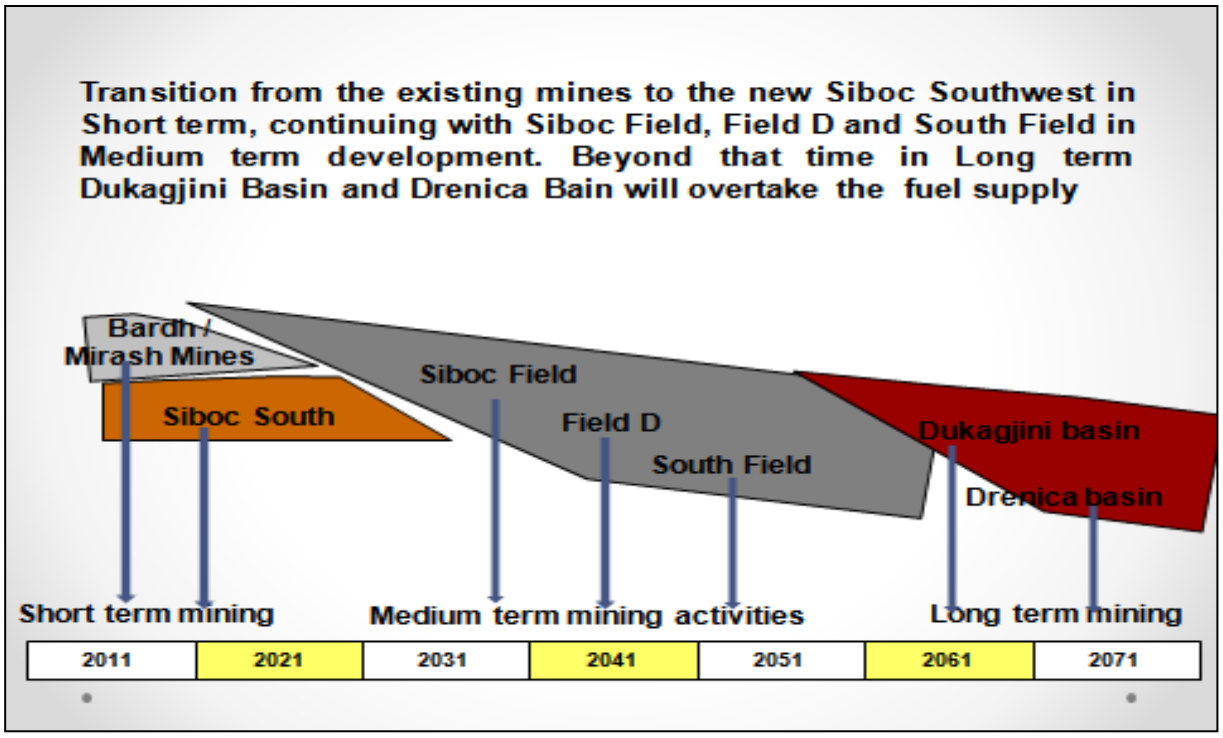


Figure 10-3: Mining activity development in short, medium and long term

Chapter XI

11.0. DEVELOPMENT OF A GUIDE FOR STRATEGIC MANAGEMENT WITH FOSSIL ENERGY RESOURCES IN KOSOVO

Sustainable development is a new and evolving approach that promotes the use of natural and other resources to improve the economy, the environment, and society—in an integrated way for the benefit of current and future generations. The production and consumption of energy comprise one of the fundamental components of economic development and societal well-being. However, development and use of fossil fuels deplete nonrenewable natural resources are not without any cost to society, both environmental (e.g., in terms of air and water quality) and social (e.g., in terms of socioeconomic impacts of development on local communities). Economic and technology status of the mineral resources production in Kosovo has been stagnating for a number of decades. On the other hand, an increasing need for energy mineral resources consumption and the drop in their average content in ores have influenced a change in their way of exploitation. Surface exploitation is the dominant way of extracting lignite resources in all countries.

Lignite, as the key mineral and thermal energy resources of Kosovo takes in 97% of the country's total energy production. A long-term concept of energy development in Kosovo presumes an increase of lignite production from the current 7.1 Mt per year to 15.7 Mt per year after decade, with possible increase in future, where the major pressure on production increase will be put on Kosovo basin in short term and medium term and later on in Dukagjini and Drenica basin. With that view, lignite exploitation requires coordination at several planning levels (national, regional and local). Intensive development of surface exploitation, as well as of facilities for lignite transformation, dynamic spatial changes, and large scope of degradation of natural and man-made environment, created a framework of specific conditions and challenges for spatial planning in the large lignite basins.

Due to the nature of spatial changes which are caused by surface mining, planning in the mining areas is faced with a number of specific development, environmental, social and spatial constrains and limitations. Applied research in this field considers structural spatial changes, socio-economic implications, possibilities for revitalization of damaged areas, and the environmental as well as the quality of life improvements in the mining activity's immediate zone of influence. The experience confirms that research and planning process for the mining areas should be a continuous one, encompassing forecasts and development solutions for

the various time horizons: long-term (40-80 years), medium-term (10-40years), short-term (1-10 years). Within the scope of integral and regional approaches, the strategic planning in large mining basins is founded on long-term forecasts (and research). Newly opened pits are typically planned for the period of 25-30 years, where the process of preparation, including design, takes around 10 years. Coal production and prospective activation of new open pits, as well as development of mining-energy systems in the mining basins in general require steering through coordinated planning actions. The goal is to achieve sustainable development of the energy sector within new institutional, organization and economic settings. Implementation of standards for environmental and social protection through plans for the lignite mining sector development in Kosovo is exposed to two types of challenges. First one is the focus on competitiveness growth and wish to sustain economic development versus environmental and social equation, and the second one is adaptation to externally suggested standards to local conditions, institutional and legal framework.

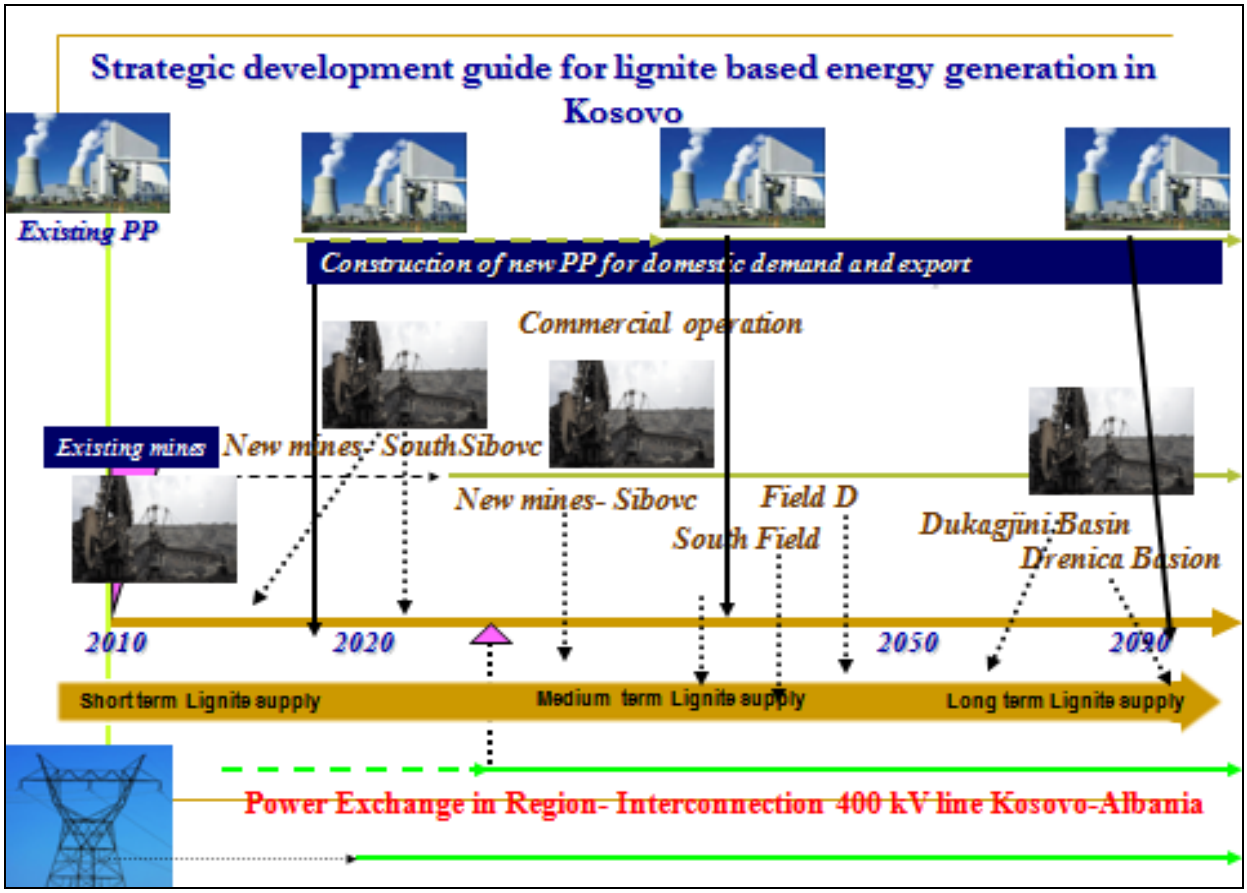


Figure 11-1: Strategic development guide for long term based energy generation in Kosovo

Strategically integrated resource optimization is the most essential part of the work done here and main task is to construct the development guide and obtain the final solution is affected by many factors (see below in the figure).

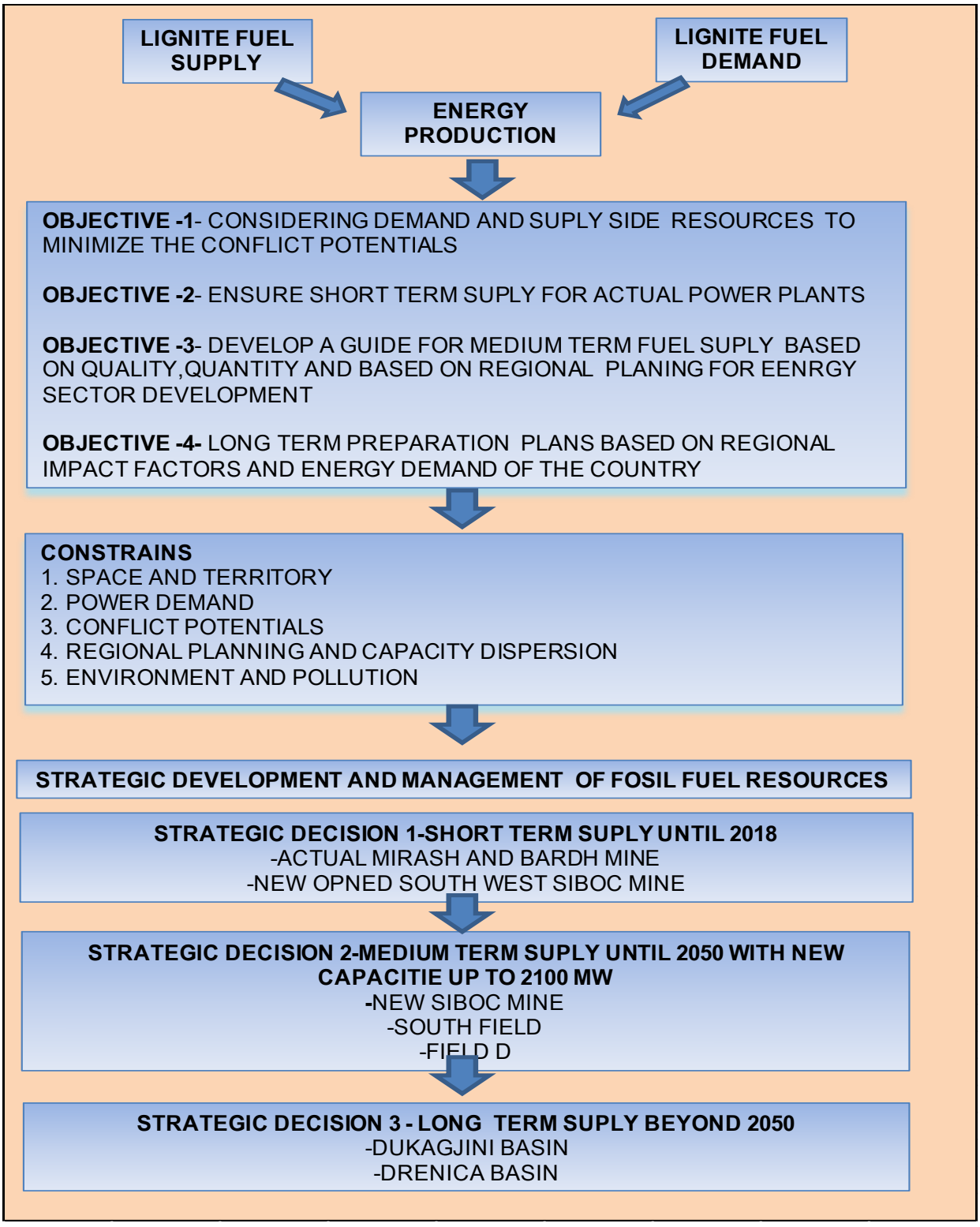


Figure 11-2: Strategic management of lignite fuel supply for short, medium and long term developments in the Kosovo's energy sector

As mentioned above, the goal is to minimize the constrains and costs and meet future power demand through strategically and regionally divided important lignite fields on both the supply and demand sides. This objective is the function of strategic planning, which concerns minimizing the total costs (including the constrain costs, costs of power plant expansion, operating, environmental protection, heritage protection etc.). Studies show that in 10 years the domestic energy demand could be doubled comparing to today's one and this means double increase on lignite demand in order to ensure secure energy production for the country.

Due to low cost production, it's likely that Kosovo will become a major energy production center in the region. This trend should be controlled to avoid Kosovo becoming a country to provide others with cheap energy and cause damages to environment. Thereof external cost should be included into production cost in all possible scenarios for future energy production. Planning for energy and resource intensive products should be made, to avoid possible environment and economic damage. For strategic planning and policy development purposes, the energy sector must be organized and analyzed according to the following themes, shown graphically in figure 11-3.

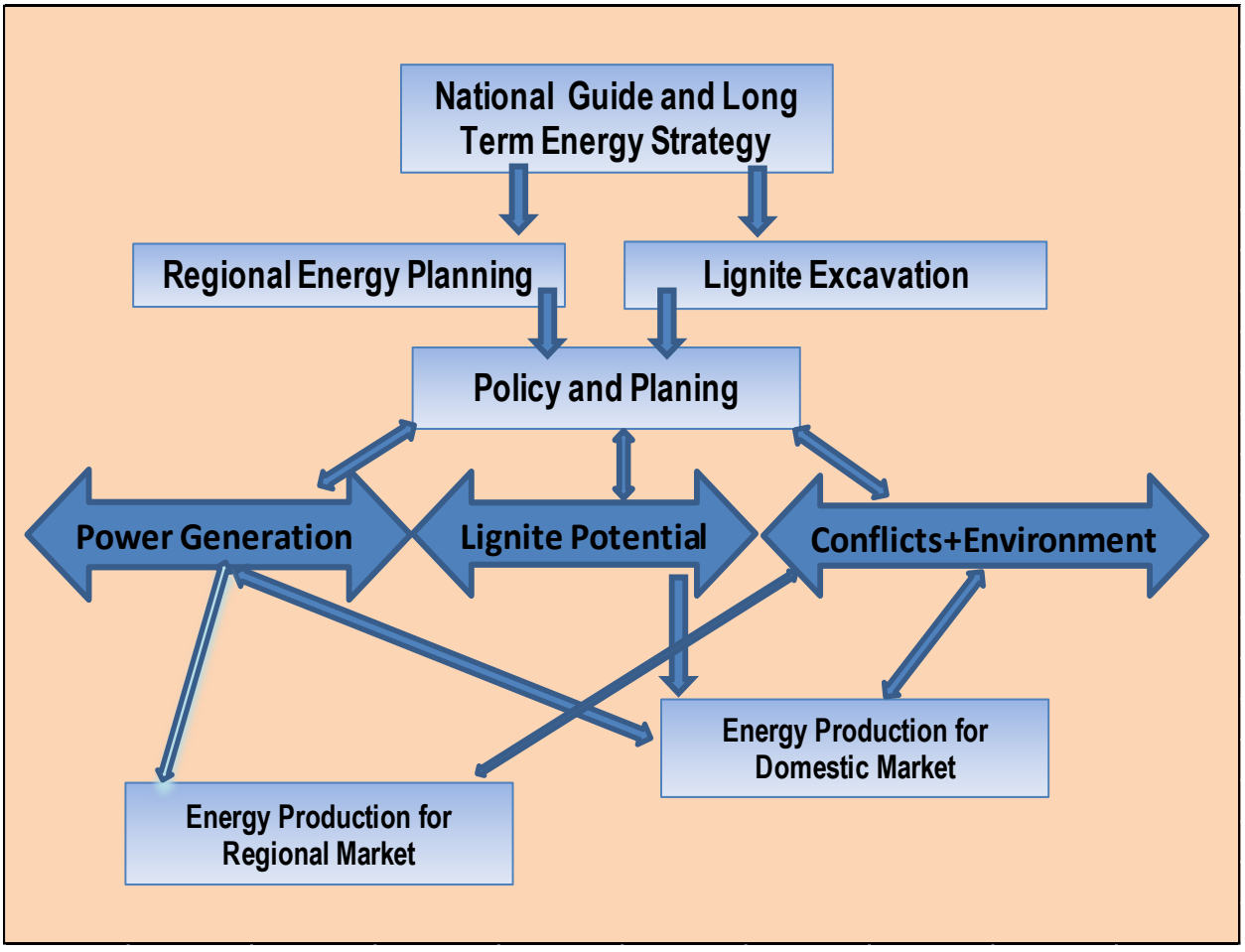


Figure 11-3: Strategic planning of lignite potential for energy production

Except above mention impact factors, the development of the long term policy statements and strategies for Kosovo is allocated based on the regional dispersion of lignite, quantity and power plant size, as well domestic and regional energy demand. Guidelines for the definition of development policies include: regional development, investments, taxes, credits and other forms of stimulations; energy, agriculture, water management, industry, services, development of settlements, protection and promotion of the environment; social and individual standard, etc. All aspects of development of the mining, energy industry sector and its surroundings must be the subject of continuing research. In that relation it would be necessary to elaborate and occasionally update long and medium term, as well as annual, research programs and establish special funds for this purpose. Continuing research work, development planning, monitoring and control require the development of a specific segment of the information system and monitoring of the Mining, Energy, and Industry Sector.

Development and use of the information system, organization and monitoring of research, development planning, arrangement and revitalization of space and solution of development constrains in this area requests appropriate institutional solutions. For this purpose, geological and hydrological maps, soil maps and commodity are evaluated. This includes information about the geological setting, the gradient of the layer boundaries, the position of the layers as well as brushing and geotechnical impacts in mineral fields. As a result of exploration of the deposit for each of the studied deposits is a statement about this commodity, its quantity, location and extent in the subsurface and the quality of fuel is analysed as well. These statements with regard to all necessary parameters are more reliable, more detailed exploration is made and finally the recommendations are settled.

The classification of deposits in different important areas takes place through the evaluation and the collection of the existing of fuel quality and quantity, regional dispersion and constrains potentials. The work under this approach developed the evaluation of lignite deposits in Kosovo in terms of constrain assessment, in this form as a universal assessment. Having in mind that Kosovo is small country and the population density is among the highest in Europe the Regional dispersion of lignite deposits and possible future use of them in regional basis has played decisive role as well. As a result of exploration of the deposits for each of the lignite fields is explained the statement about this commodity, extraterritorial areas, its quantity, location and extent in the subsurface, possible power plant size and the quality. Based on the results of exploration of the deposit potential estimation and classification of deposits in priority classes are defined and carried out [21].

The division into priority classes is developed done by using the stocks of raw material, quality, regional or the geographical situation of the occurrences (total area, depth, ratio of overburden to thickness of deposit), but also using the existing infrastructure (existing treatment plants or in the immediate vicinity) or the geopolitical situation (political stability, constrain regions). The goal and purpose is to create a hierarchy of storage with the lowest potential for constrain. In the constrain analysis, the deposits of a certain areas are to be selected into high, medium and low priority classes. These potential mining areas are determined

from their respective parameters (storage extension, constrain potentials, ratio of overburden to raw material quantity, quality and other potential conflicts.

In addition to the consideration of the constrain potentials within mining areas there is need to bring down the mining field alternatives always taking into account also mining technical requirements in terms of optimal field shape and field size. For a definition of field boundaries the environmental and space aspects are also taken into account. Other important factors such as mining layout, quality, quantity, geological thickness ratios, balance sheet ratios, aeromechanics, hydrogeology and the field form determine finally the importance of each analysed field.

Based on the specific constrain values and taking into account other impact factors the ranking of fields is made. The approach to the points is described in chapters before. However those ranking shows only statements about the constrain situation of a deposit. This second tool in the form of a further ranking is determined by the volume of recoverable raw materials and regional approach. This field may be determined from the inventory of geological studies and the previously planned reduction field variations are calculated. It shall consider the field size, the depth position of the raw material, a defined-quality and quantity, the deposit thickness and the density of the extracting raw material.

As guidance for the ranking may be required that minimum supply to be defined (for example in this work the minimum quantity is above 100Mt of lignite in order to be ranked. The results can be calculated for all possible deposits, evaluated and ranked finally in an overall ranking. The overall ranking may be also influenced from other parameters that were not taken into consideration, (old ash dumps for example) and they can be integrated, so that where appropriate, an evaluation or devaluation of individual deposits or mining field variations can be made.

The overall ranking created in this way, can be used then as a basis for securing raw materials supply and can be used specially for the protection of natural resources in the context of a commodity hedging concept early documented and with final aim that those natural resources will be protected. It is precisely to define what parameters are met, why there is a classification in the highest or medium priority class and which decisions can take place. At this point you can base also in factors which in the previous considerations were not taken into account (e.g., balance sheet ratios, specific land use).

The deposits of the highest priority may proceed, for example, as priority areas while the medium category can be ordered as precautionary areas in the future planning and thus be expelled to a special protection against other subject uses. Based on this and the division into priority classes an assessment of the supply periods by the investigated deposits is possible. This gave the guideline for the possible expected economic output and secure energy production of the country (Figure 11-7). This guide based on the strategic management of lignite resources specifies the objectives and measures necessary to implement energy sector policies that is also required in order to honor international environmental obligations, and to conform to energy management practices implemented throughout the European Union.

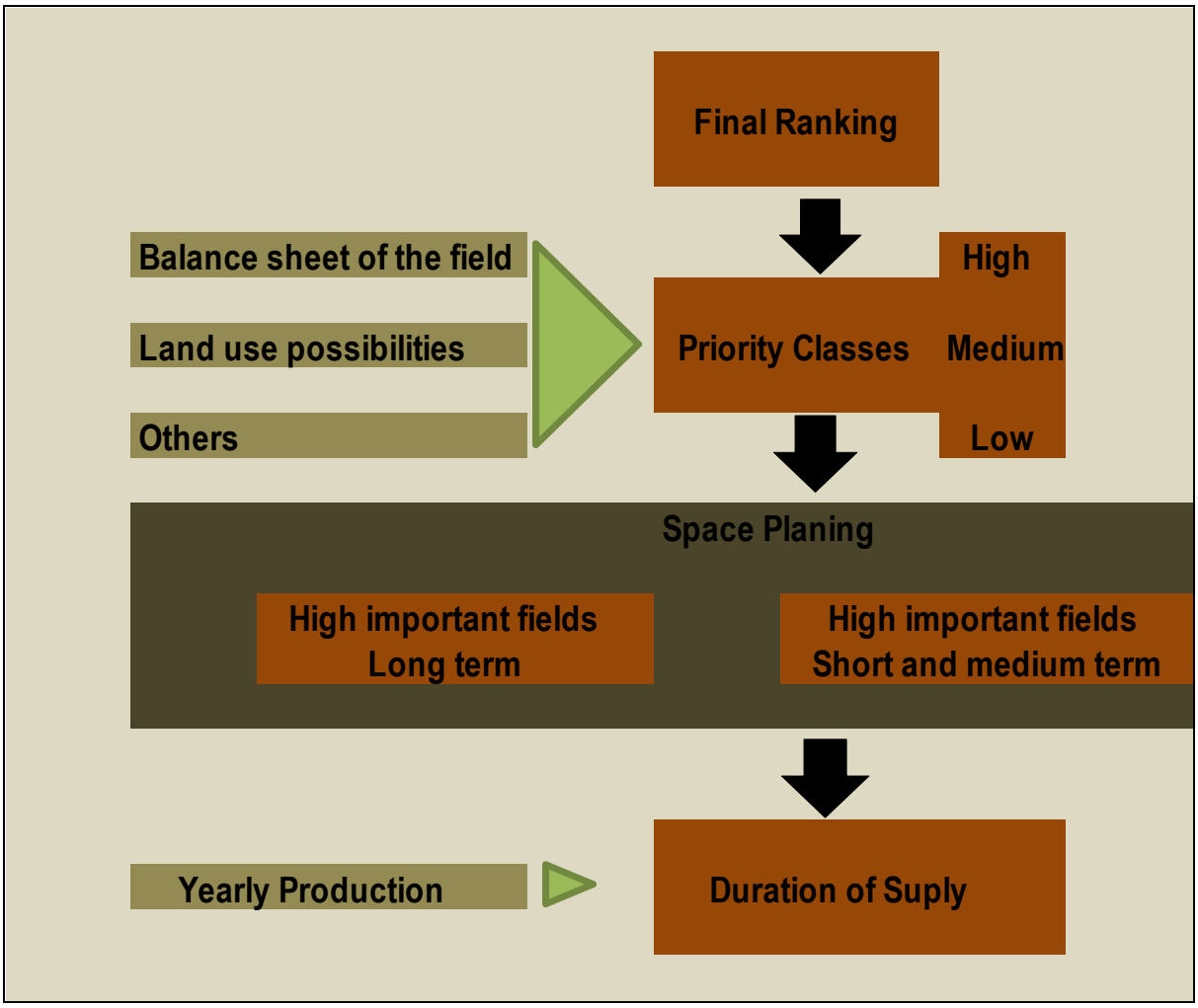


Figure 11-4: Priority Classes, Planning and Supply Periods

This work suggests a specific energy sector development model for Kosovo where the following elements are taken into consideration as key elements and basis for the final evaluation:

- all short-term measures need to conform to a long-term perception of lignite mining and energy sector development in Kosovo;
- the concept of sustainable development needs to be incorporated into all measures, keeping in mind that the environment is invaluable resource;
- the development guide needs to be conform to regional, european and world-wide energy sector tendencies and markets;
- diversification of energy sources based in regional dispersion within the country ;
- strategically sustain the use of energy resources and
- strategically sustain research, development and demonstration of new, clean and efficient technologies;

Executive Summary

Relative scarcity of electric energy sources in region and its surroundings, compared with other countries, speak of the exceptional interest of these lignite basins for energy development and thereby also for the overall development of the country. These circumstances suggest that rational utilization of this kind of energy sources is necessary. Capital investments are involved in the construction of mining and energy facilities, and the effects thereof are not fully manifested until these facilities have become operation. The negative effects of investments into exploitation and use of lignite are revealed in a relatively narrow space, while the positive, external effects are spread wider through energy consumption. A number of negative external effects are manifested in a relatively short time (occupation of space, destruction of agricultural land) while the other (larger) part are only revealed in a longer term (degradation of natural resources, environmental pollution, endangered functioning of everyday life of surrounding settlements, social-economic transformations and relocation of household and settlements, ecological consequences of harmful emissions etc.). However, it is certain that their manifestations are of predominantly long term nature.

The area of influence of lignite exploitation in large lignite basins is relatively limited (based on capital investments, occupation of land) in some aspects, somewhat wider in others (degradation of the environment, relocation of settlements, negative external effects), and in others still goes beyond regional boundaries (energy use). This suggests that the problems of long term development, manifested in large lignite basins (large structural changes, non-functional economic development, degradation of natural resources and the environment as a whole, resettlement etc.) cannot be perceived and solved in local frameworks, but only in the context of overall development of wider territorial units, thus within regional development.

Therefore, long term development of large lignite basins and long term policy for spatial arrangement and rehabilitation in zones of their influence, in terms of their contents, importance, nature, forms and area of manifestation belong to the sphere of regional planning. The long term nature of lignite utilization, as well as structural changes, constrains and negative effects in the zones of their influence, impose the need for long term planning, on the one hand, while on the other, the specific development characteristics and consequences of mining activities and energy production on a wider territorial scale call for regional planning.

Long term management and planning in large lignite basins is also important in view of the large number factors and the need to harmonize their interests and activities. Furthermore, the regional approach also provides the most appropriate platform to mitigate structural disproportion in development, neutralize development constrains and perceive (positive and negative) external.

The present work had the objective to establish a guide for the evaluation of deposits in terms of emerging environmental issues and space planning with final aim to provide a basis for the creation of a raw material ranking list in order to create a security concept. The structure of the work was divided into a description of the study methodology, actual problem analysis and a presentation of the basic concepts for lignite field assessment.

For the existing lignite deposits of Kosovo the approach was to make an assessment that helps regarding the security supply of fossil fuel for energy production of the State of Kosovo. In this evaluation alongside the technical mining aspects also space and environmental aspects are considered and evaluated. Through a detailed recording of the topographical, environmental and spatial information, emerging constrain potentials of each site are identified and evaluated. In the first constrain class are included different specific constrains, total land use for lignite exploitation, quantity and quality, the population therefore, every lying settlements in the affected areas in terms of area and number of inhabitants is considered and evaluated. A second major potential for constrain have been considered protected areas. Other important factors that are analyzed and evaluated are quality and quantity of fuel by individual fields. The next great potential for constrain is existing roads and railway infrastructure, economic impact and number of possibility to employ people, natural protected areas and extraterritorialities impose as well limitation but as well impacts in economic development. Based on this information lignite fields are analysed and ranked. Firstly, for each mining site it is designed first alternative that was based on the mining technical framework, geological data on quality and quality and shows the maximal possible stock of raw material. The second alternative considered major constrains within the deposit and the field shape was designed after evaluation of each constrains class and final point allocation.

Based on the identified specific parameters and impact factors all lignite fields were defined in a subsequent step by step and this assessment was the result of the constrain classes evaluation for each of the considered types of constrains and advantages (inhabitants, protected areas, quality, quantity and infrastructure etc.), and particular points of constrain classes were assigned. This figures that were used for the resettlement constrains, protected areas, quality and quantity, infrastructure and railway lines have been weighted according to the local conditions and their importance is defined after analysis in domestic sectorial activities. The weighted evaluation points were added up and the results in the form of an overall score in a ranking are compiled. In parallel, the quality and quantity data of lignite fields are used to estimate the duration of secure fuel supply for the state of Kosovo. Special consideration was in this context of mining areas, where the possibility to be in connection of existing mines is considered. Following fields are defined by a proximity to an existing mine, so degrading specific inputs, such as special drainage measures and infrastructural facilities for this connection field advantage can be exploited. The result was

that in the maximum variant there is 5701 Mt of lignite resources exploitable. In second variant, almost 4197 Mt of lignite can be assessed. These figures are applicable in regard of the production of all deposits in both alternatives. In this regard it is analyzed the situation for secure energy supply of Kosovo for long term period with an lignite yearly demand about 25 Mt of lignite, than the state of Kosovo has secure energy production for own needs and possible export in the region over next hundreds of years. This based on an approximation that each new power plant in size of 500 MW will need yearly an amount of 4Mt of lignite supply. The approach under this work is developed as an evaluation and strategic management of lignite deposits in Kosovo, with the aim of creating a basis for a concept of raw material protection and modern planning use of natural resources.

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a --Annum, year

ESTAP Energy Sector Tech Ass. Project

EU European Union

GDP Gross Domestic Production

KEK Korporata Energjetike e Kosova

GJ giga joule

GWh gigawatt hour

kcal kilo calorie

kcal / kg kilo calorie per kg

kJ kilo Joule

LV Low Voltage

O&M Operations and Maintenance

p.a. Per Annum

MEM Ministry of energy and mines

ROM Run Off Mine

TPP Thermal Power Plant

CC-Constrain classes

EUR Euro

MEUR Million Euro

HGS High gros scenario

MGS medium gross scenario

B cu m billion cubic meter

M^2 cubic meter (bank)

kj/kg kilo joule per kilogram

kV kilovolt

kW kilowatt

kWh kilowatt hour

Mt Million ton

M cu m million cubic meter

INKOS-Research Institute

MW megawatt

MWh megawatt hour

Km^2 square kilometres

t ton

Ha Hectare

m^3 cubic meter (m^3 in tables

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